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16. ABSTRACT

This guideline document was prepared to briefly describe the actions that must be taken by State and local air pollution control agencies to develop SIP's that demonstrate attainment and maintenance of the PM_{10} NAAQS. The guideline describes how to: (1) demonstrate attainment of the PM_{10} NAAQS, (2) determine the size of an area exceeding the NAAQS, (3) select a receptor or dispersion model, (4) prepare an emission inventory and, (5) determine a control strategy design concentration. The guideline also discusses ambient PM_{10} monitoring requirements and data usage and EPA's policies for making the transition from a SIP designed to protect TSP standards to one designed to protect PM_{10} standards. References to supporting documents are given at the end of each section.

This guideline does not discuss implementation of PSD or preconstruction review programs for PM_{10}. Guidance for implementation of these programs will be issued separately.

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June 1987

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This guideline is issued by the Environmental Protection Agency to assist State and local air pollution control agencies in developing State implementation plans (SIP's) for the national ambient air quality standards for particulate matter. The standards for particulate matter have been revised to address particles nominally 10 micrometers and smaller in diameter (PM_{10}). Copies are available - in limited quantities - from the Library Services Office (MD-35), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711; or, for a fee, from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

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1.0 INTRODUCTION

1.1 Overview

The 1977 amendments to the Clean Air Act (Act) Pub. L. 95 95) require the Environmental Protection Agency (EPA) to review periodically and, if appropriate, revise the criteria on which each national ambient air quality standard (NAAQS) is based along with the NAAQS themselves.[1,2] In response to these requirements, EPA revised the primary and secondary NAAQS to apply to particulate matter in a size range defined by the collection characteristics of a new ambient reference method that has a 50 percent collection efficiency (D_{50}) at 10 micrometers.[3,4] The material collected by the reference method is nominally below 10 micrometers and is referred to as "PM_{10}."

The purpose of this document is to provide guidance on how States can develop PM_{10} control programs for attaining and maintaining ambient PM_{10} standards. Existing State control strategies to attain and maintain the former NAAQS for total suspended particulates (TSP) provided for controlling particulate matter sources; however, they must be evaluated and revised as necessary to attain or maintain the PM_{10} NAAQS. The guidance herein addresses the transition that States must make from TSP control programs to PM_{10} control programs and the necessary revisions to State implementation plans (SIP's) to account for PM_{10}.

This document is intended as a starting point for anyone seeking information, policy, and guidance on developing PM_{10} SIP's. Most aspects of developing a PM_{10} program from problem determination to final SIP submittal are covered. Certain details of program development, however, require explanation not included herein. Reference is therefore made to other documents for those additional details.

Guidance for revising existing SIP's to address the review of PM_{10} under State and local preconstruction review programs is not included in this document. It should be noted, however, that EPA's decision to implement the revised particulate matter NAAQS via section 110 of the Act means that EPA will not impose Part D new source review (NSR) requirements as a means of revising the SIP's. Instead, the preconstruction review of major new and modified stationary sources which emit PM_{10} will be carried out largely under regulations for the prevention of significant deterioration (PSD). The reader is referred to section IV.D in the preamble of the FEDERAL REGISTER notice promulgating PM_{10} amendments to the PSD regulations for a description of the changes that EPA has made to address PM_{10}. Additional guidance will be forthcoming in the form of workshop and policy and guidance memoranda to address revisions needed for State and local preconstruction review procedures.

1.2 Guideline Contents

Since the size range of particles covered by the PM_{10} NAAQS is different from that included in TSP, the actions that States will have to take in preparing PM_{10} control programs are more complicated than they would be if only the levels or averaging method of the NAAQS had been changed. As a result, States must look at the spatial distribution of ambient PM_{10} concentrations and at source emissions from a particle size distribution standpoint. The major sections of this document are intended to provide guidance on the different aspects of PM_{10} control strategy development and SIP submittal to EPA in light of this new focus on the PM_{10} size range.

1.2.1 Determining the Air Quality Status of Areas

The Act requires control strategies to be submitted to EPA within 9 months of the revision of NAAQS. Section 2.0 describes EPA's policy for determining when the air quality of an area is or may be violating the PM_{10} NAAQS and the extent of the area violation. The EPA's policy for categorizing areas into three groups based on the need to revise their SIP is also discussed.

1.2.2 Ambient monitoring

Each State must establish an ambient monitoring network utilizing PM_{10} samplers. Section 3.0 discusses the changes made to the ambient monitoring requirements of 40 CFR Part 58. These changes address PM_{10} ambient network design, various aspects of network implementation and operation, ambient data reporting, and the air pollution subindex for PM_{10}. Other facets of ambient monitoring are also discussed, such as episode monitoring and the use of data obtained by non-reference or equivalent method samplers.

1.2.3 Modeling

Section 4.0 discusses modeling PM_{10} with dispersion models or with receptor models and describes how the two techniques can be interfaced. The section specifies models or combinations that States should use depending on various considerations such as source types, modeling objectives, and available ambient data.

1.2.4 Emission inventories

Where States use dispersion models to assess the impact of a source or sources on ambient PM_{10} levels, the model inputs must be in terms of PM_{10} emissions. Section 5.0 discusses how PM_{10} emissions can be calculated and explains in detail the type of information needed for various dispersion models now available as well as models now under development. Data needs for receptor models are also included.

1.2.5 Development of control strategies

Section 6.0 identifies general approaches to the use of ambient measurements and model estimates in setting control strategy emission limits. It explains how design concentrations may be determined and how control strategy demonstrations may be conducted using models.

1.2.6 SIP requirements and data reporting

Section 7.0 discusses EPA's policies for requiring PM_{10} SIP's based on area categorization and for transferring from a control strategy for TSP to one for PM_{10}. Also discussed are PM_{10} emission data reporting requirements in 40 CFR 51.322, the fugitive dust policy, and the emission trading policy.

1.2.7 Types of receptor models

Appendix A lists various receptor model techniques available and discusses each.

1.2.8 Preliminary Estimate of PM_{10} Design Concentration Using TSP Data

Appendix B provides a method for making a preliminary estimate of the PM_{10} design concentration when only TSP data are available; however, this estimate alone cannot be used for developing control strategies. In addition to providing a preliminary estimate, it can also provide useful information for evaluating design concentrations estimated by dispersion modeling.

1.2.9 Source testing

One of the methods for determining a source's PM_{10} emissions is to conduct a test which measures the amount of emissions plus particle size distribution. Appendix C discusses the state-of-the-art for such source testing and provides information upon which States can base an emissions measurement or compliance test method for PM_{10}.

1.3 General SIP Approach

States have many years of experience in developing and implementing plans for abating particulate matter air pollution. In general, the activities States will engage in to attain PM_{10} NAAQS will not differ radically from past activities to attain TSP NAAQS. That is, the basic approach will still be to examine air quality across the State, delineate areas where air quality needs improvement, determine the degree of improvement necessary, inventory the sources contributing to the problem, develop a strategy to reduce emissions from contributing sources enough to bring about attainment of the NAAQS, implement the strategy, and take the steps necessary to ensure that NAAQS are not violated in the future.

The change in the particle size range to which the standards apply from TSP to PM_{10}, together with the emergence of receptor models as effective tools in strategy development, necessitates changes in the specifics of particulate matter control strategy development. The major difference in past TSP strategies and new PM_{10} strategies will be the need to inventory the sources of the PM_{10} size fraction and to focus on control of PM_{10} emissions to reduce ambient PM_{10}. This could include applying PM_{10} emission factors to sources, in some cases testing sources for PM_{10} emissions, and utilizing receptor models, where feasible to refine emission inventories and augment dispersion models. The contribution of sources to ambient PM_{10} and the degree of emission reductions necessary can then be determined.

References

1. Air Quality Criteria for Particulate Matter, AP-49, U.S. Department of Health, Education, and Welfare, Washington, D.C., January 1969.

2. Air Quality Criteria for Particulate Matter and Sulfur Oxides, EPA-600/8-82-029a-c, Environmental Criteria and Assessment Office, Environmental Protection Agency, Research Triangle Park, N.C., March 1983.

3. High Volume Method for Suspended Particulate Matter, Part 50 of Chapter I of Title 40 of the Code of Federal Regulations, Appendix B.

4. Reference Method for the Determination of PM_{10} in the Atmosphere, Part 50 of Chapter I of Title 40 of the Code of Federal Regulations, Appendix J.

2.0 DETERMINING AIR QUALITY STATUS OF AREAS

2.1 Policy Overview

The Act requires that States develop SIP's that provide for timely attainment and maintenance of NAAQS. The method of determining whether an area is in attainment of the PM_{10} NAAQS using ambient air quality data is described in Appendix K of 40 CFR 50. Generally, 3 years of PM_{10} data are required to make the determination; however, data collected over shorter periods of time may be adequate as explained in Appendix K and in the Guideline on Exceptions to Data Requirements for Determining Attainment of Particulate Matter Standards.[1] In areas where too little PM_{10} data are available to demonstrate attainment of the NAAQS, EPA's policy is to use whatever PM_{10} data are available and supplement it with TSP data to determine the probability that the area will violate the PM_{10} NAAQS. The EPA will use the report, Procedures for Estimating Probability of Nonattainment of a PM_{10} NAAQS Using Total Suspended Particulate or PM_{10} Data,[2] hereafter referred to as the "probability guideline," for calculating an area's probability of nonattainment. Areas will be grouped into three categories based on their probability of nonattainment and other factors influencing the degree to which the existing SIP may need revisions. Generally, Group I areas are shown to be or have high probability of nonattainment, Group II areas are those areas where nonattainment is uncertain, and Group III areas are shown to be or have a high probability of attaining the NAAQS. After the initial grouping of areas and promulgation of the PM_{10} NAAQS, only PM_{10} data may be used to make definitive attainment/ nonattainment decisions in accordance with Appendix K or reference 1, above. The probability guideline may continue to be used for planning purposes such as to assess new areas where TSP data indicate a need for more extensive PM_{10} monitoring.

2.2 Demonstrating Attainment

Appendix K specifies the procedures which States can use to demonstrate attainment of the 24-hour and annual PM_{10} standards at a particular location using ambient air quality data. To determine PM_{10} attainment of the 24-hour standard, EPA generally requires averaging the number of estimated 24-hour exceedances over 3 consecutive years of representative data. If the average number of 24-hour NAAQS exceedances is greater than 1.0 per year, then a nonattainment problem will be evident and States should proceed to examine the adequacy of the existing SIP. A potential problem of nonattainment of the 24-hour PM_{10} standard can be projected on the basis of fewer than 3 years of data, since the criteria for nonattainment can be equivalently expressed in terms of the total number of estimated exceedances within a 3-year period. In the simplest case, if four exceedances are observed in a single year, the average number of exceedances over a 3-year period will exceed 1.0. If the total number of estimated exceedances in 3 years is equal to or greater than 3.2, then the number of exceedances averaged over 3 years would also exceed 1.0. Thus,

$3.2/3 = 1.07$, which rounds to 1.1

$3.1/3 = 1.03$, which rounds to 1.0

As soon as 3.2 estimated exceedances are accumulated a nonattainment problem will be evident. This may occur in even less than a single year.

As specified in Appendix K, EPA will not require adjustment of the first observed exceedance in order to account for incomplete sampling if (1) only one exceedance occurred in the calendar quarter, (2) if everyday sampling is initiated as expeditiously as possible as required by 40 CFR 58.13, and (3) 75 percent data capture is achieved (see section 3.2.5 of this document). As specified in 40 CFR 58.13 for the first year of monitoring, everyday sampling must commence within 90 days of the end of the calendar quarter in which the first exceedance is observed and continue for 4 consecutive calendar quarters. In addition, if a site is already monitoring every day and observes its first exceedance, no adjustment for missing data will be made to this first exceedance if 75 percent data capture is achieved.

By not adjusting the first observed exceedance, EPA is assuming that this first exceedance may be the only actual exceedance during the entire year. If, however, one or more subsequent exceedances are observed during the transition period following the first exceedance, but prior to the actual initiation of every day monitoring, the additional exceedances would be adjusted to account for incomplete sampling using formula [1] of Appendix K, according to the sampling frequency and data capture at that time.

Days on which exceedances of the NAAQS were recorded may be flagged as exceptional events in accordance with the Guideline on the Identification and Use of Air Quality Data Affected by Exceptional Events, EPA-450/4-86-007.[3] State or local control agency flagged data values may be excluded from initial NAAQS calculations and not be considered by EPA in determining an area's apparent nonattainment status. The flagged data will be excluded from final consideration of SIP adequacy if the responsible control agency determines in conjunction with a public review that the flagged data are inappropriate for use.

When the minimum 3 year data requirements specified in Appendix K are not satisfied, attainment can still be demonstrated, but such demonstrations must be approved by the appropriate Regional Administrator, in accordance with the Guideline on Exceptions to Data Requirements for Determining Attainment of Particulate Matter Standards.[1] In particular, if only 1 or 2 years of PM_{10} data are available, then supplementary information provided by modeling or other surrogate measures must be used to demonstrate the adequacy of the SIP to attain and maintain the standards.

Finally, in the event that there has been a trend in emissions during the attainment test period, attainment with the standards can be demonstrated according to Appendix K, even though the most recent 3 years of data do not indicate attainment. Either the most current representative year(s) could be used or statistical techniques or models could be used in conjunction with previous years of data to adjust for trends. Such analyses would be performed in accordance with existing guidance and must be approved by the appropriate Regional Administrator.[4]

2.3 Estimating Probability of Nonattainment to Determine Initial SIP Requirements

The procedures EPA will use to categorize areas into Group I, II, or III are discussed in section 2.4. The schedules for submitting SIP revisions and control strategy demonstrations for each group are discussed in section 7.3. If available PM_{10} data for an area are adequate to demonstrate attainment as discussed in section 2.2, then the area will be put into Group III. On the other hand, if the PM_{10} data alone are adequate to demonstrate that the area is nonattainment, it will be put into Group I. If available PM_{10} data alone are not adequate to demonstrate attainment or nonattainment, EPA's policy is to supplement available PM_{10} data with inhalable particulate matter data (particles with an aerodynamic diameter less than 15 micrometers) and TSP data. These air quality data will be used in a statistical methodology as described in the probability guideline to estimate the probability that the PM_{10} NAAQS will be violated in the area. Initially, areas will be grouped based on probabilities of nonattainment of 95 percent or greater (Group I), from 20 to 95 percent (Group II) and less than 20 percent (Group III). Other factors that may influence the degree to which the existing SIP may need revisions will also be considered in the area grouping process.

Also, EPA has found that some uncertainty exists in the PM_{10} data collected prior to 1987 with available PM_{10} instruments. A study performed by EPA in Phoenix has shown that in extreme situations data collected by Sierra Anderson SA-321A size selective PM_{10} instruments can be influenced by coarse particles to the extent that concentrations may be biased high by up to 20 percent. In addition, data collected with Wedding or GMW-9000 instrument may be biased low by up to 20 percent due to soiling problems.[5,6] In order to account for the uncertainty associated with such PM_{10} concentrations in calculating the probability of nonattainment, a zone of uncertainty or "gray zone" of ± 20 percent is being placed around the standard (0.8 NAAQS to NAAQS, lower gray zone; NAAQS to 1.2 NAAQS, upper gray zone). By design, the zone of uncertainty will only cause areas to move from Group I to Group II, or from Group III to Group II. In particular, for SA-321A instruments, 24-hour PM_{10} observations and annual PM_{10} means (using all data) within the upper gray zone are not to be counted as exceedances of the respective standards in the probability calculations. Similarly, for the GMW-9000 instrument, 24-hour PM_{10} values and annual PM_{10} means (using all data) that are within the lower gray zone are to be counted as potential exceedances of the respective standards in the probability calculations.

If an area's nonattainment probability using TSP data and PM_{10} data drops below 0.95 or rises above 0.20, as a result of PM_{10} data in the "gray zone," it will be classified Group II in order to resolve the possible uncertainty associated with the PM_{10} data and to ensure that a determination is made as to whether the existing SIP provides for attainment and maintenance of the PM_{10} standards. Also, PM_{10} data in the gray zone, by itself, will not be allowed to move an area into Groups I or III from any other Group. Areas classified Group II as a result of PM_{10} data in the upper "gray zone" are still required to operate air quality monitors on an everyday sampling schedule for the first year. This is consistent with the requirements for Group I areas as explained in section 3.2.5.

The following table presents the actual values associated with the "gray zones."

TABLE 2-1

PM_{10} Gray Zone Limits (ug/m^3)

Averaging Time	PM_{10} NAAQS	Gray Zone Limits	
		Upper	Lower
Annual	50	60*	40**
24-Hours	150	180*	120**

---

*Applies to readings made with a SA-321A
**Applies to readings made with a GMW-9000

Since the conditions under which these potential instrument biases were observed are not considered typical, data collected with all instruments will be taken at face value when demonstrating attainment or nonattainment with the standards. For data produced by the SA-321A (with the potential positive bias), however, an appropriate downward adjustment will be permitted for attainment demonstrations if influence by coarse particles can be demonstrated. For data produced by the GMW-9000 (with the potential negative bias), no adjustments to observed data are necessary for demonstration of nonattainment. Such areas with potential exceedances of the PM_{10} NAAQS (i.e. with data in the lower gray zone) will be required to sample more frequently for the first year (according to the Group II monitoring frequency of every-other-day), so that true nonattainment situations will soon become apparent.

2.4 Area Categorization

SIP development requirements are based on an area's categorization into Group I, II, or III of EPA's policy for PM_{10} SIP development. If ambient PM_{10} data adequate to determine attainment or nonattaiment of PM_{10} standards are available, they are to be used in categorizing areas. Areas for which adequate ambient PM_{10} data are not available are initially categorized into these groups using nonattainment probability (section 2.3) cut points of 95 percent to distinguish between Group I and Group II and 20 percent to distinguish between Group II and Group III. The EPA Regional Offices, in conjunction with State and local agencies may then make adjustments to the grouping based on the adequacy of the existing particulate matter SIP's for achieving and maintaining PM_{10} standards.

The general criteria for group categorization are:

Group I - Areas for which the existing particulate matter SIP may need substantial revision to be adequate for attaining and maintaining PM_{10} standards.

Group II - Areas for which the existing particulate matter SIP may be adequate or need only minor adjustment.

Group III - Areas for which the existing particulate matter SIP's are believed adequate to attain and maintain the PM_{10} standards.

Examples of information other than air quality data that may warrant moving an area from Group III to Group II, or from Group II to Group I, are:

° facts showing that the current air quality is attributable to an economic slowdown or some other temporary phenomenon rather than the stringency of the area's TSP SIP requirements,

° facts suggesting that there are few enforceable measures in existing SIP's yet to be implemented that would reduce emissions that significantly affect air quality, and

° evidence that the area has an unusually high proportion of sources in categories whose emissions typically have a higher ratio of PM_{10} to total particulate matter.

Examples of information other than air quality data that may warrant moving an area from Group I to Group II, or from Group II to Group III, are:

° factors suggesting that sources are not yet in compliance with SIP measures that, if enforced would reduce emissions that significantly affect the area's air quality;

°evidence that the area has an unusually high proportion of sources in categories whose emissions typically have a low ratio of PM_{10} to total particulate matter; and

° evidence that the area is rural in nature and is a clearly impacted by fugitive dust (i.e. qualifies as a rural fugitive dust area under the fugitive dust policy described in section 7.11).

Examples of information that may affect EPA's classification of an area not preliminarily classified using a nonattainment probability are:

° the amount and density of industrial activity that would likely result in significant ambient PM_{10} concentrations in the area;

° the number and density of roadways in the area that are near activities likely to generate significant particulate matter emissions and that are subject to moderate and heavy vehicle traffic; and

° the degree to which the existing TSP SIP will likely limit PM_{10} emissions from these traditional and nontraditional sources.

2.5 Area Boundaries

Section 6.0 of the probability guideline describes several approaches for determining the boundaries of an air quality level represented by one or more monitoring stations. In some instances the spatial extent of areas of uniform PM_{10} air quality status may differ from the areas previously defined for TSP; therefore, States may wish to use the guidance in these instances to more specifically define the spatial extent of PM_{10} air quality problems.

The approaches that have been used and that are recommended for defining area boundaries are:

-- a qualitative analysis of the area of representativeness of the monitoring station, together with consideration of terrain, meteorology, and sources of emissions;

-- spatial interpolation of air monitoring data; and

-- air quality simulation by dispersion modeling.

These techniques can be used singly or in combination depending on the complexity of the area where a monitoring station(s) is located. More detailed discussions of the techniques are in the probability guideline.

References

1. Guideline on Exceptions to Data Requirements for Determining Attainment of Particulate Matter Standards, U.S. EPA, RTP, N.C. EPA-450/4-87-005, April 1987.

2. Pace, T. G., N. H. Frank, E. L. Meyer, and S. F. Sleva, Procedures for Estimating Probability of Nonattainment of a PM_{10} NAAQS Using Total Suspended Particulate or PM_{10} Data, U.S. EPA, RTP, N.C. EPA-450/4-86-017, December 1986.

3. Guideline on Identification and Use of Air Quality Data Affected by Exceptional Events, EPA-450/4-86-007, U.S. EPA, RTP, N.C. July 1986.

4. Guidance on Accounting for Trends in Particulate Matter Emission and Air Quality Data, memorandum from R.G. Rhoads to Regional Air Directors, U.S. EPA, RTP, NC. May 11, 1987.

5. L. Purdue et. al., Intercomparison of High-Volume PM_{10} Samplers at a Site with High Particulate Concentrations, JAPCA, Vol. 36, No.8, Aug. 1986, pp. 917-920.

6. Uncertainty of PM_{10} Data Collected with High-Volume Size Selective Inlets, Memorandum from L.J. Purdue to Richard Rhoads, U.S. EPA, RTP, N.C. September 15, 1986.

3.0 AMBIENT MONITORING AND DATA USAGE

3.1 Ambient PM_{10} Monitoring

States must establish ambient monitoring networks to measure PM_{10} just as they measure ambient levels of other pollutants for which NAAQS have been set. Requirements for a PM_{10} network are included in 40 CFR 58 as are the ambient monitoring requirements for other pollutants. Existing ambient monitoring networks measure total suspended particulate with high volume samplers (hi-vols.)* Data from hi-vols, as discussed previously in section 2.0, will not allow sufficiently accurate estimates of PM_{10} levels to determine PM_{10} attainment or nonattainment with certainty. Ambient samplers meeting the requirements of 40 CFR 50 and 53 will be necessary to meet the ambient monitoring requirements of Part 58 except as specified in Appendix C of Part 58.

The requirements for PM_{10} reference or equivalent methods with a nominal D_{50} of 10 micrometers are contained in 40 CFR 50, Appendix J, and in 40 CFR 53. The EPA will designate reference and equivalent method samplers as soon after promulgation of these requirements as possible. Some provisions are made, however, as discussed in subsection 3.3, for using other ambient data until data from ambient PM_{10} networks are available.

3.2 Part 58 Requirements

3.2.1 Quality Assurance

The quality assurance (Q/A) requirements for PM_{10} samplers are essentially the same as for hi-vols. Only one minor change was made to the quality assurance procedures in Appendix A of Part 58. Section 4.2.1(a) of Appendix A requires only that the percent differences for paired measurements from collocated samplers above certain levels (20 ug/m^3 for PM_{10}) be calculated and reported. Previously, measurements below these levels were reported. Otherwise, Q/A procedures for PM_{10} monitoring in both Appendices A and B are identical to those for TSP monitoring.

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*Described in 40 CFR 50 Appendix B of Part 50

3.2.2 Ambient monitoring methodology

The requirements in Appendix C of Part 58 which require reference or equivalent method samplers be used in State and Local Air Monitoring Stations (SLAMS) apply to PM_{10} with one exception. Section 2.2 of Appendix C allows the hi-vol method to be used in a PM_{10} station as a substitute for a PM_{10} reference or equivalent method sampler as long as the ambient concentrations measured by the hi-vol are below the levels of the PM_{10} NAAQS. In such an instance, compliance with PM_{10} NAAQS is assured if the hi-vol levels are consistently below those NAAQS; thus, there is no real need from a compliance standpoint to install a PM_{10} sampler. If TSP levels rise above PM_{10} NAAQS, however, the State must install PM_{10} samplers in order to measure actual PM_{10} levels to be certain PM_{10} NAAQS are maintained.

Also, section 2.2 of Appendix C requires that at TSP National Air Monitoring Stations (NAMS) the hi-vol be continued in operation for at least a year after the PM_{10} monitoring begins. This will allow a site-specific relationship between TSP and PM_{10} data to be developed and provide assistance in checking validity of PM_{10} data. Historical trends for ambient levels of particulate matter can thus be estimated.

Section 4.0 of Appendix C, which previously applied to episode monitoring for TSP, has been revised to apply to PM_{10}.

3.2.3 Network establishment

Title 40 CFR 58.20 requires a description of the SLAMS network be available to the general public and be submitted to EPA approximately 6 months after PM_{10} NAAQS are promulgated. The network description need not be included as part of the SIP; it need only be kept updated and made available for public inspection. Two dates, 1 year and 2 years after promulgation, are included in section 58.23 for completion of the PM_{10} SLAMS network. By 1 year after promulgation of the NAAQS, each area within the approved SLAMS network for which a probability of PM_{10} NAAQS nonattainment is greater than or equal to 20 percent, must have at least one PM_{10} sampler in operation which is (1) located in the area of expected maximum concentration (2) sited in accordance with Appendix E, (3) located as described on the station's Storage and Retrievel of Aerometric Data (SAROAD) identification form, and (4) meeting all quality assurance requirements in Appendix A pertinent to PM_{10}. The remaining PM_{10} samplers, including those in areas with nonattainment probabilities below 20 percent, have until 2 years after promulgation of the NAAQS to be fully operational and to meet the siting and quality assurance requirements.

The same submittal date (6 months after promulgation) also applies for the description of the NAMS portion of the SLAMS network as required by section 58.30. The date by which all stations in the NAMS portion of the SLAMS network are to be in operation and meeting Part 58 requirements is 1 year after PM_{10} NAAQS are promulgated (section 58.34).

3.2.4 Network design

Information on designing SLAMS and NAMS networks is contained in Appendix D of Part 58. The material is largely self-explantory and, as indicated in Appendix D, should be used jointly by States and EPA Regional Offices for designing ambient monitoring networks. To account for PM_{10} network design, Appendix D has been amended to include criteria for determining the number of PM_{10} stations and areas in which to locate them. In addition to Appendix D, a document entitled Network Design and Optimum Site Exposure Criteria for Particulate Matter[1] is available and provides further information on designing PM_{10} networks and siting ambient samplers.

3.2.5 Sampling interval

The sampling interval for PM_{10} data collection will not necessarily be once in 6 days as it has been for TSP. Short-term and long-term strategies have been added to section 58.13. During the first full year of sampling the short-term strategy requires daily sampling at at least one site (the site of expected maximum concentration) in areas with a PM_{10} nonattainment probability of 95 percent or greater. Sampling is required every other day at least one site in areas with nonattainment probabilities between 20 percent and 95 percent. Sampling in areas with a probability below 20 percent may be once every sixth day. The use of the term "area" as it applies to the required sampling frequencies of the "area" is as follows: (1) any urbanized area as defined by the U.S. Bureau of Census, (2) any incorporated place such as a city or town as defined by the U.S. Bureau of Census or group of cities or towns, and (3) any "area" designated by the responsible air pollution control agency. In designating these latter "areas," the control agency should consider technical factors such as the types of emissions, their spatial distribution, meterology, and topography and how these factors contribute to the uniqueness of the "area" thereby distinguishing it from other designated "areas." The first year of PM_{10} data collection is to start no later than the appropriate dates in section 58.23 and section 58.34 for completion of the SLAMS and NAMS networks, respectively. The year can start, however, as soon as the station is put into operation.

The long-term strategy applies after the short-term strategy ends (in most cases after the first full year of sampling ends). The sampling interval will then vary according to the relationship of air quality levels to the NAAQS. The closer the air quality levels to the NAAQS, the more frequently sampling must be carried out. A table depicting the requirements appears in section 58.13.

As soon as the first exceedance of the 24-hour PM_{10} NAAQS occurs in an area which historically has had a less than everyday sampling interval, the requirements change to everyday sampling for at least one site (the site of expected maximum concentration). The State will have up to 90 days after the end of the quarter in which the exceedance occurred to implement everyday sampling at the site of expected maximum concentration, and it must be maintained for at least 4 calendar quarters, but preferrably 1 full calender year. If the day on which the first exceedance occurred was flagged as an exceptional event, the State must still implement everyday sampling, unless exempted by the Regional Administrator.

3.2.6 Sampler inlet siting

The criteria in Appendix E of Part 58 for siting ambient PM_{10} samplers is very similar to the previous siting criteria for hi-vol samplers. The new criteria for the PM_{10} SLAMS include microscale stations which were not previously included for the TSP SLAMS network. An inlet height of 2 to 7 meters is specified for PM_{10} microscale stations. The inlet height for all other scales for PM_{10} stations is 2 to 15 meters as it was previously for all TSP SLAMS. The spacing requirement from roadways is also different. For microscale roadway stations, the PM_{10} sampler must be between 5 to 15 meters from major roadways. For middle, neighborhood, and urban scale PM_{10} stations a range of separation distances are specified for each as a function of traffic volume and the scale of representativeness.

3.2.7 Ambient data reporting

The reporting requirements in Part 58 for ambient data apply for PM_{10} as they do for the other pollutants; i.e., all SLAMS data must be reported annually in summary form and all NAMS data must be reported quarterely. Since the regulations allow for the use of TSP monitors as a surrogate for PM_{10} monitors under certain conditions, the reporting requirements for TSP data remain in Appendix F of Part 58. The TSP data summary format in section 2.2 of Appendix F, however, has been changed to correspond somewhat with the format added for PM_{10} data in section 2.7 of Appendix F. The ranges for the 24-hour summary report have been in 50 ug/m^3 increments. The format added for PM_{10} is in 25 ug/m^3 increments. A significant change made in the reporting requirements is the provision that annual TSP data must be reported as arithmetic means, 24-hour TSP data values must be reported if they exceed the level of the 24-hour PM_{10} NAAQS, and the sampling interval must be reported. Otherwise TSP reporting requirements remain unchanged.

Section 2.7 has been added to Appendix F to cover reporting of PM_{10} data. All exceedances of the 24-hour PM_{10} NAAQS, the sampling interval, and the number of 24-hour values within 30 ug/m^3 ranges must be reported.

3.2.8 Air pollution index

The air pollution subindex for TSP has been replaced by a subindex for PM_{10}. The breakpoints for the subindex reflect the levels of the PM_{10} short-term standard. A new table of breakpoints and a graphic display of the breakpoints is included in Appendix G of Part 58.

3.3 Ambient Samplers and Ambient Data Usage

3.3.1 Ambient samplers in use

Considerable ambient data have been collected using hi-vols, hi-vols with size-selective inlets with a D_{50} of 15 micrometers (SSI_{15}), and dichotomous samplers with inlets designed for D_{50} of 15 micrometers. Some data have been collected using samplers with inlets designed for a D_{50} of 10 micrometers. The PM_{10} samplers cannot be designated as PM_{10} reference or equivalent method samplers, however, until Part 50 and Part 53 requirements are promulgated, and subsequent manufacturer test data are examined and accepted by EPA. Thus, the PM_{10} data now available have not been collected by reference or equivalent methods. Therefore, nonreference or equivalent method PM_{10} data, PM_{15} data, or TSP data may be used for initial SIP development purposes, subject to certain constraints.

3.3.2 Interim use of non-reference or equivalent method samplers

Until PM_{10} reference or equivalent method samplers can be designated, manufactured, purchased, and installed in PM_{10} SLAMS, States should continue to operate approved ambient samplers with inlets designed for a nominal D_{50} of 10 micrometers. Approval of ambient PM_{10} samplers for SIP purposes will be made by the Environmental Monitoring Systems Laboratory, MD-77, Environmental Protection Agency, Research Triangle Park, North Carolina 27711.

Data from these approved samplers will be acceptable for use in modeling and in determining an area's attainment status. Use of these data for initial SIP classifications are discussed in section 2.4.

3.3.3 Episode monitoring

The criteria for determining which areas are required to have air pollution episode contingency plans are in Subpart H of Part 51. The sampling procedures that should be used for determining air quality levels during air pollution episodes are similar to those used prior to promulgation of the PM_{10} NAAQS. These procedures are identified in section 4.0 of Appendix C of Part 58 and are further described in the document, Guideline for PM_{10} Episode Monitoring Methods.[3] Briefly, two methods based on the filtration principle are recommended; staggered PM_{10} sampling and short-term interval sampling. The staggered sampling procedure uses a 24-hour sampling procedure followed by a 2-hour post-sampling filter equilibration period. The short-term interval sampling method requires a 4-hour sampling period followed by a 2-hour filter equilibration period. In addition to these two procedures, other methods may be used provided the user demonstrates a site-specific correlation of the alternative method with the reference method.

3.4 SIP Revisions

That portion of the SIP providing for ambient monitoring should be revised, if necessary, to include provisions for a PM_{10} ambient network. If the ambient monitoring portion of the SIP provides for monitoring pollutants "for which NAAQS have been set," then no revision is necessary. If the SIP lists pollutants, PM_{10} would need to be added to the list. The PM_{10} SLAMS network design need not be included in the SIP and a SIP revision is not necessary as a result of any network modification. Any

SLAMS network modifications, however, must be approved by the appropriate EPA Regional Office and any NAMS modifications by EPA's Office of Air Quality Planning and Standards.

Reference

1. Koch, R.C. and H.E. Rector, Network Design and Optimum Site Exposure Criteria for Particulate Matter, GEOMET Technologies, Inc., Rockville, MD. Prepared for U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA Contract No. 68-02-3584. March 1983.

2. Pace, T.G. and N.H. Frank, Procedures for Estimating Probability of Nonattainment of a PM_{10} NAAQS Using Total Suspended Particulate or PM_{10} Data, U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA 450/4-86-017, December 1986.

3. Pelton, D.J., Guideline for PM_{10} Episode Monitoring Methods, GEOMET Technologies, Inc. Rockville, MD. Prepared for U.S. Enviromental Protection Agency, Research Triangle Park, NC. EPA Contract No. 68-02-3584. February 1983.

4.0 AIR QUALITY MODELING FOR PM_{10}

4.1 Introduction

Section 51.12 of 40 CFR requires that the adequacy of a control strategy for attainment and maintenance of NAAQS be demonstrated by means of a dispersion model or other procedure which is shown to be adequate and appropriate for this purpose. The Guideline on Air Quality Models (Revised)[1] provides guidance on dispersion modeling for particulate matter and lists preferred dispersion models for this purpose. Procedures collectively known as receptor models are also available that examine an ambient monitor sample of particulate matter and the conditions of its collection to infer the types or relative mix of sources impacting on it during collection. Receptor models are described briefly in Appendix A and the references to this section.[2,3] The most widely used and accepted quantitative receptor model is the chemical mass balance (CMB).[4] The proper use of the CMB is described in two protocols referenced in this section.[5,6]

Three options are presented herein for estimating the air quality impact of emissions of PM_{10} using dispersion and receptor models: (1) use of receptor and dispersion models in combination (preferred): (2) use of dispersion models alone; and (3) use of two receptor models, with control strategy developed using a proportional model (discussed in Section 6.0). This latter approach is only encouraged if no applicable dispersion model is available. Several considerations relevant to model selection are presented in Section 4.2 (Receptor Models) and 4.3 (Dispersion Models). The PM_{10} is generally referred to in the following discussion. Where there is insufficient technical data to support an analysis for PM_{10} with these models, the same procedures may be applied to TSP, except as specifically noted, as a surrogate for PM_{10}.

4.2 Considerations in Receptor Model Selection

Several considerations related to the nature of sources emitting PM_{10} influence selection of the receptor model(s) for SIP purposes. These are the availability of particle size data and the size range of the emissions from predominant sources, prior knowledge of the sources, chemical similarity of the sources, the need to identify individual sources vis-a-vis source categories, and the time scale of interest. Different factors affecting choice of receptor models are summarized in Table 4-1 and discussed below. One key overriding selection consideration is that CMB is considered the most advanced of the receptor methods listed in Table 4-1. The other methods include factor analysis (FA), automatic scanning electron microscopy (ASEM), and microscopy (OM). The FA, ASEM, and OM are not generally considered quantitative and FA requires at least 40 samples to complete an analysis. The reader is referred to the Receptor Model Technical Series (references 2, 4, 5, 6, 7, 12, 13, 16) for technical, cost, and applicability information.

4.2.1 Particle size

Many researchers have discussed the bimodal distribution of particulate matter which is related to the tendency of some source categories to emit predominantly fine (<2-3 um) or coarse (>2-3 um) aerodynamic diameter particles. Sources which emit predominantly fine particles include those involving the combustion of fuels (motor vehicles, boilers, field burning, woodstoves, etc.) and industrial processes involving combustion, chemical reaction, or condensation of vapors. Contributors to coarse particles in the atmosphere include windblown dust from storage piles, agricultural fields, etc., vehicle resuspended road dust, pollens, and fugitive emissions from industrial process sources. Various receptor models such as species mass balance and factor analysis are well suited to analyze sources of

TABLE 4-1

SELECTING FEASIBLE SOURCE APPORTIONMENT METHODS BASED ON DATA AVAILABILITY AND SOURCE CHARACTERISTICS

	Fine	Coarse	Sources Known	Sources Unknown	Chemical Similarity	Fingerprints Dissimilar	Isolated Single Source	Air Shed (Source Categories)	Air Shed (Specific Sources Within Category)
Mass Balance (CMB)	Y	Y	Y		a,b,Y	Y	Y	Y	b,Y
Factor Analysis (FA)	X	X	X	X	b,X	X	X	X	
Automated Scanning Electron Microscopy (ASEM)	c,X	X	X	X	b,X	X	X	X	b,X
Microscopy (OM)	c,X	X	X	X	b,X	X	X	X	b,X
Dispersion Model (DM)	YY	YY	YY		YY	YY	YY	YY	YY

a - Initial use of factor analysis may be helpful.

b - Useful if a source can be isolated from other similar sources by wind direction. Method usually cannot otherwise distinguish between sources in same category.

c - Useful for fine particles larger than 1.0 um

X - Appropriate to use in conjunction with CMB or DM.

Y - Appropriate to use with DM or FA, ASEM or OM.

YY - Appropriate to use.

either fine or coarse particles. Optical and scanning electron microscopy are suitable for coarse and fine particles down to about 1 micrometer in size but work better on coarse particles. Most receptor models generally work best when the sample is segregated by size range (e.g., fine and coarse) because these two size ranges are associated with different types of sources.

4.2.2 Prior knowledge of sources and emissions

In many instances, the sources suspected of contributing to ambient PM_{10} concentrations at a particular site are apparent. However, the relative contribution of each source is needed. Any of the methods discussed in Appendix A could be used to give source apportionment information if the sources are identifiable, provided the other requirements for using the method are also met. However the mass balance requires knowledge of sources and their emission characteristics. If some sources are unknown, FA, ASEM, or OM might prove useful if done prior to a CMB analysis.

4.2.3 Chemical similarity

The availability of "fingerprints" for the sources of interest will often determine the optimum receptor model to use. A fingerprint is the characteristic chemical or morphological pattern of the emissions from a source that is used to distinguish it from other sources.[17] Some sources have fairly distinct fingerprints, while others do not. Since combustion source emissions are predominantly composed of carbon, there is very little information upon which to differentiate among the different types of combustion sources. Some help might be gained by examining the optical properties, by using carbon dating (C^{14}/C^{12} ratios) which can distinguish between modern or fossil carbon (e.g., wood smoke versus fuel oil), or by using minor tracer constituents (e.g., K in wood). Other common fingerprint problems include the difficulty in distinguishing among sources whose emissions are comprised of various soil components or between flyash and soil. Optical properties can be useful for some situations where fingerprints are similar. Also, X-ray diffraction (XRD) is very useful in identifying various minerals by examining their crystalline structure.

4.2.4 Sources versus source categories

Any of the receptor models listed in Table 4-1 or Appendix A can be useful in identifying the impact of an isolated specific source unless its fingerprint is similar to that of background. Likewise, the techniques can be used to identify many of the source categories within an airshed consistent with the limitations identified in the preceding discussion. However, the impact of specific individual sources within an airshed containing multiple sources of the same type may not be reliably identifiable except on wind directional samples or by a dispersion model.

4.2.5 Particle size and time scale

In some cases ambient PM_{10} or PM_{15} data may be available for SIP apportionment. In other cases, only TSP data are available. The availability of PM_{10} data, or PM_{15}, or TSP will determine to some extent the type of source apportionment method used for PM_{10} since the PM_{10} signature of a source may be significantly different from the PM_{15} or TSP signature. Another important factor is the time scale of the nonattainment situation (annual or 24-hour). Table 4-2 contains recommended approaches for source apportionment based on the time scale (annual or 24-hour) of the nonattainment problem and the data base available. The choices listed in each block of the table are in order of preference, with the preferred approach listed first. These approaches are discussed in more detail in the following sections.

TABLE 4-2

RECOMMENDED APPROACHES FOR PM_{10} SOURCE APPORTIONMENT

AMBIENT DATA BASE AVAILABLE	
PM_{10}	TSP*
Applicable dispersion and receptor model	Applicable dispersion model corroborated by ASEM or optical microscopy**
Applicable dispersion model	
Receptor methods (at least 2) CMB w. corroborating method	Applicable dispersion model

* TSP may be used as a surrogate, where PM_{10} data bases are inadequate.

** Other receptor models such as Mass Balance may be used if fine particle data (generally less than 2-3 micrometers) are collected in addition to TSP.

4.3 Screening Techniques and Refined Dispersion Models for PM_{10} Concentrations

It may sometimes be appropriate to conduct a preliminary screening study to determine likely causes of nonattainment prior to a major control strategy development effort. This generally is confined to use of existing ambient samples and emissions data and usually gives only a qualitative or "first approximation" of sources. Such a screening study has two advantages. First, the qualitative prioritization of sources can be used to design the more definitive study, which is usually required for control strategy development. This may enable substantial cost savings, since the screening study can be focused on specific areas of concern. Second, in some cases, the source contribution may be very clear and the screening study may be all that is required prior to control strategy development. This is further discussed in the references to this section.[7]

4.3.1 Selection of appropriate dispersion models

Several publications are available that contain hand calculation methods for arriving at preliminary (screening) estimates of PM_{10} concentrations.[8,9,10] In general, these methods are based on the assumption that all particulate matter behaves as a gas in the atmosphere, i.e., neglecting settling and deposition. Although subjective values for "half-life" or pollutant decay have been used occasionally as a surrogate for particle removal in screening methods and also some models, such procedures are not generally recommended for PM_{10} analysis. For screening analyses, the conservative assumption of negligible removal is warranted, considering the size of the particles.

Dispersion models that can be used for estimating PM_{10} concentrations are listed in Table 4-3. All models are available on UNAMAP Version 6 from National Technical Information Service (NTIS) as PB 86-222361. Emission inputs for those models not considered screening techniques are discussed in Section 5.0. It should be noted that only the ISC model explicitly treats settling and deposition of particles and can accept particle size data, in as many as 11 size fractions. No model recommended for regulatory use at this time handles secondary particle formation or other transformations in a manner suitable for SIP control strategy demonstrations.

However, EPA has completed work on two models, PEM-2 (an urban model) and MESOPUFF-II (a medium scale transport model), that can provide supporting analyses. These models include provision to input a settling velocity appropriate to particle size, a deposition velocity characteristic of the pollutant-surface interaction, and a rate (percent per hour) to describe the transformation of primary gas pollutant to secondary particle pollutant (e.g., sulfur dioxide to sulfate). Since their accuracy, suitability, and resource requirements for regulatory applications are not well tested, no specific recommendation on the use of these models is provided here. Nevertheless, in selected applications, they may be useful in assessing the significance of background concentrations and of secondary sulfate particles in the effectiveness of control strategies. Application of these models should follow recommendation in the modeling guideline concerning the use of alternative models.

4.3.2 Special considerations for PM_{10} dispersion modeling

The Modeling Guideline[1] contains guidance that should be followed on (1) selection of appropriate source and meteorological data for use with dispersion models, (2) location of receptor sites, (3) selection of model

TABLE 4-3

DISPERSION MODELS APPLICABLE TO PM_{10} ANALYSES*

1 to 24-Hour Average	Annual Average	Screening Techniques**
CRSTER	CRSTER	PTPLU-2
MPTER	MPTER	COMPLEX I
RAM	RAM	VALLEY
ISCST	ISCLT	
	CDM 2.0	

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*For more information concerning the applicability of these models, consult the Guideline on Air Quality Models (Revised). As noted in this document, these models may also be used for TSP modeling analyses in conjunction with a suitable TSP emission inventory, as a surrogate, where PM_{10} data bases are inadequate.

**These models are considered to be screening techniques for use prior to a more refined analysis as outlined in the Guideline on Air Quality Models (Revised).

options, (4) determination of urban/rural classification, and (5) determination of background air quality. With regard to background air quality values, there is now limited data that might be used to support specific values for PM_{10} background concentrations. General guidance on the use of available data is provided in Appendix D.

Rollback and roll forward are appropriate only for preliminary analyses. Proportional models may be used in conjunction with receptor modeling if the air quality problem is clearly associated with a few specific sources. Such procedures are discussed in Section 4.4 and 6.4. For urban-wide refined analyses, CDM 2.0 or RAM may be used. For source-specific analyses of complicated sources, the ISC model is preferred to CRSTER/ MPTER because ISC is the only model that is capable of treating deposition, area and volume sources, building downwash, etc.

For those cases where no recommended technique is available or applicable, nonguideline modeling approaches for use in each specific situation must be approved by the appropriate Regional Office.

Dispersion models are more reliable for estimating longer time-averaged concentrations (e.g., annual average) than for estimating short-term concentrations (e.g., 24-hour) at specific locations.[11] Point source models are reasonably reliable in estimating the magnitude of the highest concentrations occurring some time, somewhere within an area. Errors in highest estimated concentrations of ± 10 to 40 percent are found to be typical for sources that can be adequately characterized. The multiple source urban model RAM showed no significant bias in estimating 1-hour ground level concentrations for the 13-station RAPS network in St. Louis. The average network cumulative frequency distributions of hourly estimated and observed concentrations differed by no more than 30 percent over the entire concentration range.

However, estimates of concentrations that occur at a specific time and site tend to be poorly correlated with actually observed concentrations and are much less reliable, should this performance attribute be important in a regulatory application.

4.4 Receptor Models for Estimating PM_{10} Concentrations*

4.4.1 Control strategy analyses using receptor models

Receptor models tend to be well suited for source apportionment of 24-hour PM_{10} samples. However, care must be taken to ensure that the samples analyzed are representative of the conditions causing NAAQS exceedances. The CMB is recommended as the primary method to be used in regulatory applications of receptor models to PM_{10} data.[4,12,13] There is uncertainty in any source apportionment approach. Therefore, if CMB is used for source apportionment (without combining with a DM), it is required that at least one other receptor modeling approach be used as a corroborating analysis. This may be FA, OM, ASEM, microinventory, trajectory analysis, XRD, or other corroborating approach as selected from those discussed in Volume I of the Receptor Model Technical Series[2] or the Digest of Ambient Particulate Analysis and Assessment Methods.[14] It is strongly urged that either optical microscopy or ASEM be used to corroborate CMB, along with intensive chemical analysis (sulfate, carbon and other elements) of the samples. The OM or ASEM should be used instead of CMB if only TSP data are available. It is also strongly urged that the CMB be performed on size fractionated PM_{10} (into fine and coarse fractions, below and above 2.5 um). This greatly increases the resolution of the techniques. The results of receptor model source apportionment may be used with the method discussed in Section 6.4 to estimate the degree of control required to demonstrate attainment at a given monitoring site.

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*The terms "model" and "method" are used interchangeably, even though analysis methods such as scanning electron or optical microscopy are methods, not models.

For exceedances of the annual NAAQS, the selection of days on which to perform receptor model analyses should be governed by the representativeness of the seasons where exceedances occur. For exceedances of the 24-hour NAAQS consideration, emphasis should be on those days where exceedances occurred. This selection process is discussed further in reference.[6]

4.4.2 Preliminary analyses using receptor models

Preliminary analyses can also be done using receptor models. The most common methods employed are optical or automatic scanning elecron microscopy. These techniques are relatively inexpensive (less than $500 per sample) and can give a variety of information about likely sources. They are especially useful when only TSP data are available because they can discriminate between particles less than and greater than 10 um. Other methods which may be helpful include microinventories, chemical emission inventories, and mass balance.[4,12,13] In those cases where only TSP data on glass fiber filters are available, the CMB approach is limited because some key tracers (silicon and aluminum) cannot be used. However, the CMB may be a useful preliminary procedure in areas where no steel mills or coal fired power plants are likely contributors. In such instances, certain chemical elements associated with emissions from steel mills and coal fired power plants (such as iron, Fe) may serve as useful replacements for ordinary tracers of crustal material (e.g., Si, Al) which cannot be reliably measured on a glass fiber filter. In areas where steel mills and power plants are likely sources, the microscopic methods (OM and ASEM) would usually be preferred for preliminary analyses. As suggested in Table 4-2, these are the recommended, corroborative methods for use with dispersion modeling when only TSP data are available.

4.5 Use of Receptor and Dispersion Models in Combination

Several demonstrations have been made where receptor models were used to help evaluate the results of dispersion modeling.[15] This is the recommended approach for source apportionment. It is especially useful when the emission inventory used in a dispersion model is determined to be marginally adequate. The results of the receptor model can be used to carefully scrutinize the inventory assumed in the dispersion model to deduce whether emissions from certain source categories appear to have been adequately characterized. The use of a receptor model, such as CMB, in conjunction with dispersion modeling, is highly recommended in such situations. Procedures for using the CMB and dispersion model in concert are specified in reference[6] to this section.

Guidance in Section 5.0 describes the kinds of data necessary in a PM_{10} emissions inventory used as input to a dispersion model for a PM_{10} analysis. For determining compliance with the annual PM_{10} NAAQS, dispersion models based on an annual PM_{10} emission inventory and sequential or frequency distributions of observed meteorological conditions can be used. Also, receptor models and methods such as CMB, FA, OM and ASEM, perhaps corroborated by microinventories, trajectory analysis, and XRD can be used on samples which have been carefully selected to represent the annual average. Thus, the source contributions would reflect those which cause the annual average to exceed the NAAQS.

It may be difficult to devise a PM_{10} short-term emission inventory for use in a dispersion model to characterize 24-hour episodes of high ambient particulate matter. Therefore, analysis of the observed monitoring data using a receptor model is likely to be particularly useful, in concert with dispersion model estimates. Of the receptor models discussed, CMB, OM, or ASEM, perhaps corroborated by XRD or trajectory analysis are appropriate for use with 24-hour observations, with CMB the preferred method. Factor analysis is limited to long-term data sets and is more useful in conjunction with the annual NAAQS.[16] It is recommended that TSP data not be used with receptor models for either 24-hour or annual PM_{10} analyses because the particles larger than 10 um may bias the results. An exception to this is the use of ASEM or optical microscopy in association with dispersion model estimates. This exception is permitted because ASEM and optical microscopy involve the analysis of discrete particles where their size (relative to PM_{10}) can be estimated.

Once specific 24-hour or annual average source contribution factors are obtained, the proportioning method discussed in Section 6.4 may be used to estimate control requirements.

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5.0 DEVELOPMENT OF PM_{10} EMISSION INVENTORIES

5.1 Overview

As part of the SIP development process following promulgation of PM_{10} NAAQS, emission inventories may have to be developed for PM_{10}. This section discusses various technical considerations involving the preparation of PM_{10} emission inventories. Though inventories are useful for various purposes, the primary focus of this section is on developing or reviewing PM_{10} emission inventories to be used as input to applicable air quality dispersion models. Such models are expected to be utilized as part of SIP control strategy demonstrations. Some discussion is also included on the emission inventory requirements of receptor models, which differ considerably from dispersion models in the approach used to identify source/receptor relationships as well as in the inventory data needed as input.

This section does not repeat basic guidance on the fundamentals of compiling emission inventories. It is assumed that most users of this document will have had direct experience compiling particulate matter or other inventories and will find the same general procedures applicable to PM_{10} inventories. The primary thrust of this section is to alert users to circumstances where additional materials and different methods are needed to compile PM_{10} inventories.

The two major components of PM_{10} inventories, or inventories of any pollutant to be used in dispersion modeling, are (1) a set of emission factors, and (2) source data to which the emission factors are applied to estimate emissions. Emission factors are generally compiled from source test data and represent emissions, before and/or after controls, that may be expected from a typical facility within a particular source category. The most commonly used source of emission factors is AP-42, Compilation of Air Pollutant Emission Factors,[1] which is revised periodically to include particle size data and size specific emission factors. Emission factors in AP-42 are contained in two separate volumes for stationary point and areas sources (Volume I) and mobile sources (Volume II). The PM_{10} emission factors for reentrained dust from roadways are included in Volume I. This section describes the format of these PM_{10} emission factors for stationary sources and how they can be applied to the appropriate source data to develop PM_{10} inventories. Emission inventory procedures for mobile sources are presented in a separate EPA publication.[11]

The second component of the PM_{10} inventory, source data, consists of stack and exhaust flow parameters, production levels, throughputs, control device efficiencies, etc., as well as information on source locations and plant layouts. The specific kinds of source data that are needed in the PM_{10} inventory depend on the model used for PM_{10} simulation, with the major differences involving (1) the levels of temporal and spatial resolution, (2) the description and configuration of each source, and (3) the need for chemical composition and particle size distributions. Thus, this section also identifies models currently available for PM_{10}, as well as those anticipated to be available in the next several years, and delineates the specific differences in emission inventory requirements of each of these models.

Finally, a number of specific considerations need to be made when dealing with air quality models and PM_{10} inventories. First, condensable and secondarily formed particles may become more important since both are primarily within the PM_{10} fraction. Second, since PM_{10} is a subset of total particulate matter, the question arises whether an existing particulate matter inventory, compiled for TSP analyses, can simply be modified for use in a PM_{10} application. Third, as in any modeling application requiring large amounts of input, data handling becomes an important consideration. These topics are addressed in the latter part of this section.

5.2 PM_{10} Emission Factors and Fractional Multipliers

Any emission factor is basically a multiplier which is applied to appropriate source activity levels, such as throughput or production rates, to estimate emissions. An emission factor can be a constant, implying a linear relationship between source activity and emissions, or can be variable, with parameters other than just activity levels influencing emissions. In either case, emissions are generally computed by the following relationship:

$$\text{Emissions factor} \times \text{Activity level} \times \text{Control device penetration} = \text{Emissions}$$

In the above equation, the control device penetration factor is calculated as (1 minus the control efficiency), which becomes unity if uncontrolled emissions are being calculated. This simple equation is employed regardless if emissions are being computed for total particulate matter, PM_{10}, or any other pollutant. If a set of PM_{10} emission factors is available, the preceding equation becomes:

$$\text{Emission factor}|_{PM_{10}} \times \text{Activity level} \times \text{Control device penetration}|_{PM_{10}} = \text{Emissions}|_{PM_{10}}.$$

Of course, emission factors may be utilized that already reflect the effect of certain controls, in which cases the control device penetration factor drops out of the above equation.

Alternatively, PM_{10} emissions may be computed by applying fractional multipliers to particulate matter emission estimates in an existing inventory as follows:

$$(PM_{10}\ \text{fraction}) \times \text{Emissions}|_{\text{particulate}} = \text{Emissions}|_{PM_{10}}$$

An advantage of the latter approach is that PM_{10} fractions may be available in certain cases whereas PM_{10} emission factors may not. This approach may also be easier from a data handling standpoint when converting an existing total particulate matter inventory to a PM_{10} inventory.

Thus, in compiling a PM_{10} inventory for use in dispersion modeling, one must first obtain requisite PM_{10} emission factor or size fraction information. Such information is becoming available for a large number of sources. Table 5.1 lists the stationary source categories for which EPA has developed PM_{10} emission factor and other particle size information. A majority of these factors have been distributed to State/local agencies. Additional PM_{10} information will be published in supplements to AP-42.

The PM_{10} fractions and emission factors are presented in tabular form such as are shown in Table 5-2. In the hypothetical example shown in Table 5-2, cumulative mass percents and emission factors are shown at various particle size cut points for a controlled process. In this case, PM_{10} emissions after controls could be calculated either by applying a factor of 0.06 lb/ton to the process production rate or by multiplying the existing total particulate matter emissions for the facility by 60 percent. A graphical display of the information in Table 5-2 is included in Figure 5-1.

Some agencies may elect to obtain their own particle size data for certain sources. Source testing is generally encouraged, especially for

Table 5.1

PM_{10} EMISSION FACTORS TO BE AVAILABLE FOR INDICATED SOURCE CATEGORIES, PROCESSES AND CONTROL SYSTEMS

AP-42 Section	Source Category	Process	Uncontrolled	CONTROL DEVICE				
				ESP	Fabric Filter	Scrubber	Multiple Cyclone	Other
1.1	Combustion-Bituminous and Subbituminous Coal							
		Dry Bottom Boiler	x	x	x	x	x	
		Wet Bottom Boiler	x	x			x	
		Cyclone Furnace	x	x		x		
		Spreader Stoker[1]	x		x		x	
		Spreader Stoker[2]		x			x	
		Overfeed Stoker	x					
		Underfeed Stoker	x				x	
1.2	Combustion-Anthracite Coal	Dry Bottom Boiler	x		x		x	
		Traveling Grate Boiler	x					
1.3	Combustion-Residual Oil	Utility Boiler	x	x		x		
		Industrial Boiler	x				x	
		Commercial Boiler	x					
	Combustion-Distillate Oil	Industrial Boiler	x					
		Commercial Boiler	x					
1.4	Combustion-Natural Gas	All Boilers	x					
1.6	Combustion-Bark	Wood Waste Boiler	x			x	x[1,2]	

[1] Without flyash reinjection.
[2] With flyash reinjection.

Table 5.1 (continued)

PM_{10} EMISSION FACTORS TO BE AVAILABLE FOR INDICATED SOURCE CATEGORIES, PROCESSES AND CONTROL SYSTEMS

AP-42 Section	Source Category	Process	Uncontrolled	CONTROL DEVICE				
				ESP	Fabric Filter	Scrubber	Multiple Cyclone	Other
1.7	Combustion-Lignite Coal	Boilers	x				x	
1.8	Combustion-Bagasse	Vibrating Grate Stoker				x		
2.1	Refuse Incineration	Municipal Incinerator	x					
4.2	Surface Coating	Spray Booth Water Based						x Water Curtain
5.3	Carbon Black	Oil Furnace	x					
5.15	Detergent Spray Dryer					x		
5.16	Sodium Carbonate Manufacturing	Bleacher Dryer	x	x			x	
		Calciner	x	x		x[3]	x[3]	
		Dryer	x					
		Rotary Predryer	x			x[3]	x[3]	

[3] Combined controls.

Table 5.1 (continued)

PM_{10} EMISSION FACTORS TO BE AVAILABLE FOR INDICATED SOURCE CATEGORIES, PROCESSES AND CONTROL SYSTEMS

AP-42 Section	Source Category	Process	Uncontrolled	CONTROL DEVICE				
				ESP	Fabric Filter	Scrubber	Multiple Cyclone	Other
5.17	Sulfuric Acid	Absorber	x					
		Absorber 20%	x					
		Absorber 32%	x					
		Secondary Absorber	x					
5.	Boric Acid	Dryer	x		x			
5.	Potassium Chloride	Dryer	x			x^3	x^3	
6.1	Alfalfa Dehydrating	Drum Dryer	x					
6.3	Cotton Ginning	Battery Condenser	x					
		Lint Cleaner				x x^3	x^3	
		Roller Gin						
		Bale Press	x					
		Gin Stand	x					
		Saw Gin	x					
		Bale Press	x					
		Gin Stand	x					

[3] Combined controls.

Table 5.1 (continued)

PM_{10} EMISSION FACTORS TO BE AVAILABLE FOR INDICATED SOURCE CATEGORIES, PROCESSES AND CONTROL SYSTEMS

AP-42 Section	Source Category	Process	Uncontrolled	CONTROL DEVICE				
				ESP	Fabric Filter	Scrubber	Multiple Cyclone	Other
6.4	Feed and Grain	Carob Kibble Roaster	x					
		Cereal Dryer	x					
		Unloading and Conveying	x					
		Rice Dryer	x					
6.18	Ammonium Sulfate	Rotary Dryer	x					
7.1	Primary Aluminum Production	Bauxite Ore						
		Unloading				x		
		Storage			x			
		Prebake Roof Monitor	x					
		HSS Cell	x					
7.2	Coke Production	Coal Preheat	x			x		
		Coal Charging	x					
		Coke Pushing	x			x		
		Mobile Scrubber Car - Travel Mode				x		

Table 5.1 (continued)

PM_{10} EMISSION FACTORS TO BE AVAILABLE FOR INDICATED SOURCE CATEGORIES, PROCESSES AND CONTROL SYSTEMS

AP-42 Section	Source Category	Process	Uncontrolled	CONTROL DEVICE				
				ESP	Fabric Filter	Scrubber	Multiple Cyclone	Other
7.2	Coke Production (cont.)	Mobile Scrubber Car Push Mode				x		
		Quenching with Dirty Water	x					Baffle
		Quenching with Clean Water	x					Baffle
		Combustion Stack	x					
7.3	Primary Copper	Multiple Hearth Roaster and Reverberatory Smelter	x		x			
		Reverberatory Smelter	x		x			
		Converter	x		x			
		Matte Tapping	x					
		Slag Tapping	x					
		Converter Slag and Blow Operations	x					

Table 5.1 (continued)

PM_{10} EMISSION FACTORS TO BE AVAILABLE FOR INDICATED SOURCE CATEGORIES, PROCESSES AND CONTROL SYSTEMS

AP-42 Section	Source Category	Process	Uncontrolled	CONTROL DEVICE				
				ESP	Fabric Filter	Scrubber	Multiple Cyclone	Other
7.4	Ferroalloy Open Furnace Production	50% FeSi	x		x			
		80% FeMn	x		x			
		Si Metal	x		x			
		FeCr (HC)	x	x				
		SiMn	x			x		
7.5	Iron and Steel Production	Sintering Windbox	x	x		x	x	
		Sintering Discharge Breaker			x			
		Blast Furnace Casthouse	x					
		Blast Furnace with Local Evacuation	x					
		Hot Metal Desulfurization	x		x			
		BOF Top Blown Furnace Melting and Refining				x		
		Q-BOP Melting and Refining				x		
		BOF Charging	x		x			
		BOF Tapping	x		x			
		EAF Melting and Refining	x					

Table 5.1 (continued)

PM_{10} EMISSION FACTORS TO BE AVAILABLE FOR INDICATED SOURCE CATEGORIES, PROCESSES AND CONTROL SYSTEMS

AP-42 Section	Source Category	Process	Uncontrolled	CONTROL DEVICE				
				ESP	Fabric Filter	Scrubber	Multiple Cyclone	Other
7.5	Iron and Steel Production (cont.)							
		EAF Melting, Refining, and Charging Direct Shell Evacuation			x			
		Open Hearth Furnace Melting and Refining	x	x				
7.6	Primary Lead Smelting	Blast Furnace Flue			x			
		Blast Furnace	x					
		Ore Storage	x					
		Sinter Machine	x					
		Dross Kettle	x					
		Reverberatory Furnace	x					
7.8	Secondary Aluminum	Reverberatory Furnace	x					
		Chlorination Station	x					

Table 5.1 (continued)

PM_{10} EMISSION FACTORS TO BE AVAILABLE FOR INDICATED SOURCE CATEGORIES, PROCESSES AND CONTROL SYSTEMS

AP-42 Section	Source Category	Process	Uncontrolled	CONTROL DEVICE				
				ESP	Fabric Filter	Scrubber	Multiple Cyclone	Other
7.10	Gray Iron Foundries	Cupola Furnace	x		x	x		
		EAF	x					
		Pouring and Cooling	x					
		Shakeout	x					
7.11	Secondary Lead Smelting	Blast Furance Flue			x			
		Blast Furnace Ventilation	x		x			
7.13	Steel Foundries	Casting Shakeout	x					
		Open Hearth	x	x				
7.15	Storage Battery Production	Grid Casting	x					
		Grid Casting and Paste Mixing	x					
		Lead Oxide Mill			x			
		Paste Mixing	x		x			
		Three Process	x					
7.	Tinner	Batch Tinner	x					
8.1	Asphaltic Concrete	Conventional Plant	x		x		x	Spray Tower
		Drum Mix Plant	x		x			

Table 5.1 (continued)

PM_{10} EMISSION FACTORS TO BE AVAILABLE FOR INDICATED SOURCE CATEGORIES, PROCESSES AND CONTROL SYSTEMS

AP-42 Section	Source Category	Process	Uncontrolled	CONTROL DEVICE				
				ESP	Fabric Filter	Scrubber	Multiple Cyclone	Other
8.3	Brick and Related Clay Products	Coal Fired Tunnel Kiln	x					
		Sawdust Fired Kiln	x					
		Raw Material Screening and Grinding	x					
8.6	Portland Cement	Wet Kiln	x	x				
		Dry Kiln	x		x		x	
		Clinker Cooler	x					Gravity Filter
8.9	Coal Cleaning	Dry Process			x			
		Thermal Dryer	x			x		
		Thermal Incinerator	x					
8.13	Glass Manufacturing	Furnace Exhaust	x	x				

Table 5.1 (continued)

PM_{10} EMISSION FACTORS TO BE AVAILABLE FOR INDICATED SOURCE CATEGORIES, PROCESSES AND CONTROL SYSTEMS

AP-42 Section	Source Category	Process	Uncontrolled	CONTROL DEVICE				
				ESP	Fabric Filter	Scrubber	Multiple Cyclone	Other
8.15	Lime	Rotary Kiln	x	x	x^a		x	
		Product Loading						
		Into Open Bed Trucks	x					
		Into Tank Truck	x					
		Glass Line Into Tank Truck	x					
8.18	Phosphate Rock Processing	Ball Mill					x	
		Calciner				x^3	x^3	
		Rotary Dryer				x^3	x	
		Rotary Dryer and Fluidized Bed Dryer		x^3		x^3	x^3	
		Roller Mill and Ball Mill			x^3		x	
8.22	Taconite Ore Processing	Main Waste Gas Stream		x^3			x	
8.	Feldspar	Ball Mill	x					
8.	Fluorspar	Rotary Drum Dryer			x			
8.	Lighweight Aggregate (Clay)	Coal Fired Rotary Kiln				x		S. C.[b]
		Dryer	x					
		Reciprocating Grate Clinker Cooler			x		x	

[a] Cyclone With Baghouse.
[b] S. C. = Settling Chamber.

Table 5.1 (continued)

PM_{10} EMISSION FACTORS TO BE AVAILABLE FOR INDICATED SOURCE CATEGORIES, PROCESSES AND CONTROL SYSTEMS

AP-42 Section	Source Category	Process	Uncontrolled	CONTROL DEVICE				
				ESP	Fabric Filter	Scrubber	Multiple Cyclone	Other
8.	Lightweight Aggregate (Shale)	Reciprocating Grate Clinker Cooler						S.C.[a]
8.	Lightweight Aggregate (Slate)	Coal Fired Rotary Kiln	x			x		
		Reciprocating Grate Clinker Cooler						S.C.[a]
8.	Talc	Pebble Mill	x					
10.1	Kraft Pulp	Recovery Boiler with DCE	x	x				
		Recovery Boiler without DCE	x	x				
		Lime Kiln	x	x		x		
		Smelt Dissolving Tank Vent	x			x		Packed Tower

[a] S.C. = Settling Chamber.

Table 5.1 (continued)

PM_{10} EMISSION FACTORS TO BE AVAILABLE FOR INDICATED SOURCE CATEGORIES, PROCESSES AND CONTROL SYSTEMS

AP-42 Section	Source Category	Process	Uncontrolled	CONTROL DEVICE				
				ESP	Fabric Filter	Scrubber	Multiple Cyclone	Other
10.4	Wood Working Waste	Belt Sander					x	
11.2.1	Unpaved Roads	Rural						
		Gravel	x					
		Dirt	x					
		Crushed Lime Stone	x					
		Industrial						
		Copper Smelting	x					
		Iron & Steel Production	x					
		Sand & Gravel Processing	x					
		Stone Quarrying & Processing	x					
		Taconite Mining & Processing	x					
		Western Surface Coal Mining	x					
11.2.2	Agricultural	Tilling	x					
11.2.3	Aggregate Handling	Batch Drop	x					
		Continuous Drop	x					

Table 5.1 (continued)

PM_{10} EMISSION FACTORS TO BE AVAILABLE FOR INDICATED SOURCE CATEGORIES, PROCESSES AND CONTROL SYSTEMS

AP-42 Section	Source Category	Process	Uncontrolled	CONTROL DEVICE				
				ESP	Fabric Filter	Scrubber	Multiple Cyclone	Other
11.2.5	Paved Urban Roads	Local Streets	x					
		Collector Streets	x					
		Major Streets/ Highways	x					
		Freeways/Express-ways	x					
11.2.6	Industrial Paved Roads	Copper Smelters	x					
		Iron and Steel	x					
		Asphalt Batching	x					
		Concrete Batching	x					
		Sand and Gravel	x					

TABLE 5-2. CUMULATIVE EMISSION FACTORS AND PARTICLE SIZE DISTRIBUTION FOR A HYPOTHETICAL LIME PROCESS

Particle Size (micrometer)	Cumulative Mass Percent Less than Stated Size		Cumulative Emission Factors (Pound/Ton of Product)	
	Uncontrolled	Controlled[a]	Uncontrolled	Controlled[a]
Total Catch	100	100	85	0.100
15.0	70	82	59	0.082
10.0	51	60	43	0.060
7.5	42	56	36	0.056
5.0	33	50	28	0.050
2.5	13	31	11	0.032
1.0	2.8	11	2.5	0.010
0.5	0.9	4	0.8	0.004

[a] Control Device: Baghouse.

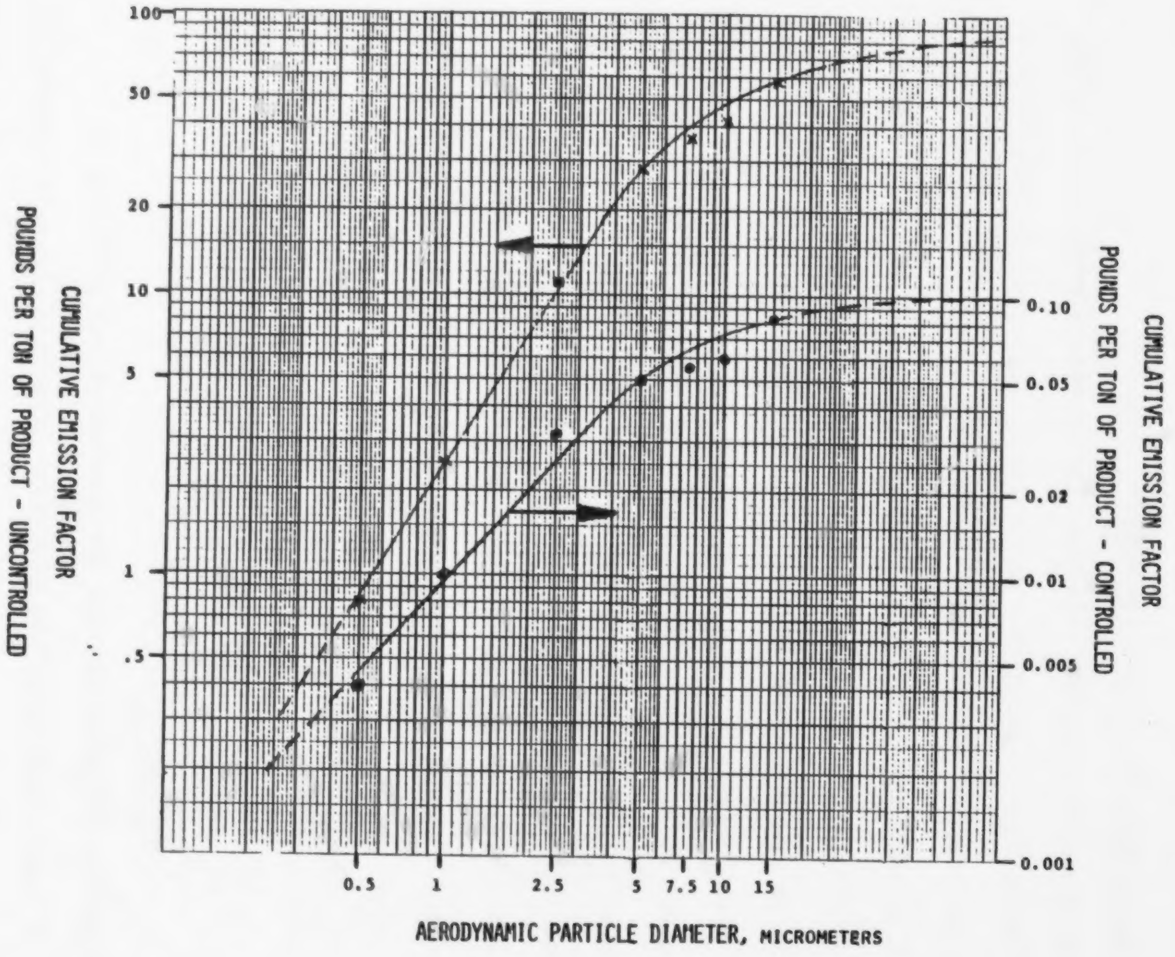

FIGURE 5-1 EXAMPLE GRAPHICAL DISPLAY OF CUMULATIVE EMISSION FACTORS VS. PARTICLE SIZE FOR A HYPOTHETICAL PROCESS

large contributors, since facility or point-specific emission estimates are considered more accurate than average estimates calculated from AP-42 factors. Any testing should be consistent with the methods described in Appendix C of this document.

5.3 PM_{10} Source Data for Dispersion Models

The second major component necessary for inventory compilation, along with emission factors or fractional multipliers, is source data describing the nature and level of activity at each facility or operation. Source data include all information on the nature and location of each source, operating rates, stack and exhaust gas parameters, and control devices employed. The kinds of source data that must be obtained depend on whether a particular source can best be described as a point, area, or line source. The degree of detail required in a PM_{10} emission inventory is dictated by the dispersion model employed for simulating air quality impacts.

As described in more detail in section 4.0, a number of models are currently available for assessing the air quality impact of PM_{10}, differing in many respects. Generically, most such models can be categorized along the following lines:

dispersion vs. receptor
individual source vs. areawide (grid)
short-term vs. long-term

Dispersion models calculate ambient air concentrations primarily as functions of source configurations, emission strengths, terrain features, and meteorological conditions. Receptor models (discussed in section 5.4) infer the relative impact of various sources on ambient air quality by reconciling particle size, and shape and chemical composition data of ambient air samples with particle size, shape and chemical composition data for various emission sources in the vicinity of the ambient air measurement site. Individual source models evaluate the impact of a single source or source complex whereas areawide (grid) models evaluate the impact of numerous sources, including area and line sources, over a larger area. Short term models estimate air quality levels for time periods from 1 hour to 24 hours whereas long-term models generally predict monthly, seasonal, or annual average concentrations. The major impacts of model choice on requisite source data in the PM_{10} emission inventories are itemized below:

-- Area covered by the inventory - Individual source dispersion models require source data to be collected for only a single stack, facility, or complex. Areawide models require source data for all sources within the defined grid system.

-- Source configuration - Some (especially point source) dispersion models require information on individual stack heights and building sizes and locations. Many dispersion models require area sources to be assigned to grid squares and some distinguish line sources from area sources.

-- Temporal resolution - Typically, the emission rates input to most applicable dispersion models are expressed in terms of grams per second for point sources, grams per second per square meter for area sources, and grams per second per meter for line sources. Actually, the emission rates input to dispersion models need not be as resolved as might be inferred from these units. Ideally, the emission rates should be as resolved as the model output. For example, if the model predicts a 24-hour average ambient air concentration, emissions should be input that reflect conditions over that 24-hour period for best results. In cases where maximum concentrations need to be predicted, maximum emission rates may need to be considered instead of a time-averaged rate.

-- Spatial resolution - Most dispersion models require point source coordinates for each stack. Area and line source emissions are typically assigned to grid squares and line segments, respectively, having arbitrary dimensions. The scale of the coordinate systems in most models is at the discretion of the user. Because of computer constraints and regulatory requirements, tradeoffs usually exist between the need for finer resolution and the overall area that can be modeled. In some cases, the maximum degree of spatial resolution is limited by the units and number of significant figures built into the model's software.

-- Size fractions - Most applicable dispersion models consider the PM_{10} fraction as a single lump sum entity requiring no particle size resolution below 10 micrometers. Several models have the capability to treat various fractions differently within the PM_{10} fraction.

-- Chemical composition - Dispersion models rarely require chemical composition data, although many receptor models do.

Tables 5-3 through 5-7 list various dispersion models that may be used for simulating PM_{10} levels, along with specific source data requirements of each model. References 2 through 7 present a detailed description of each of these models. The reader should consult these user's manuals as well as someone with modeling experience before developing an inventory as input to any of these models.

The reader will note from the information in Tables 5-3 through 5-7 that dispersion models vary considerably in their source data requirements. As was mentioned earlier, it is not the intent of this section to reiterate guidance on the fundamentals of compiling inventories. Rather, this section's primary purpose is to highlight special considerations that may have to be made when developing a PM_{10} emissions data base for modeling. Basic guidance on compiling emission inventories is given in References 8 through 14. Additional guidance is presented in Reference 15 on obtaining different levels of temporal and spatial resolution, including techniques for assigning area source emissions to grid cells.

Information on dispersion models used for PM_{10} applications is given in section 4.0 of this document.

TABLE 5-3

INDUSTRIAL SOURCE COMPLEX MODEL (ISC)[2]

Type - Dispersion

Application - Estimating local impact around complex industrial sources in rural or urban areas. Stack, area, and volume sources within the industrial complex can be accommodated. Area sources can include fugitive sources such as storage piles and slag dumps. Volume sources can include sources such as building roof monitors and conveyor belts and may also be used for simulating line sources.

Short/long term - The ISC contains both short and long term versions called ISCST and ISCLT, respectively. The ISCST maybe run for each hour of a year or ISCLT may be run for a year using frequency distributions of meteorological data and annual emissions.

Inventory area - All sources within the boundaries of the industrial complex must be included in the inventory.

Stack and exhaust data - Physical stack height, inner diameter and elevation above sea level, gas exit temperature, and velocity. If the stack is adjacent to a building and aerodynamic wake effects are to be considered, the length, width, and height of the building must be known.

Nonpoint source configurations - The horizontal dimension, elevation above sea level and effective emission heights are required for each area source or volume source.

Temporal resolution of model output - 1-, 2-, 3-, 4-, 6-, 8-, 12- and 24-hour values may be selected for calculation by ISCST and annual averages are calculated by averaging all 24-hour concentrations. Seasonal and/or annual values are calculated by ISCLT.

Actual emissions units input to model - grams/second for stack and volume sources,
grams/second-meter^2 for area sources.

Spatial resolution of source data - Source elevation above mean sea level and source locations with respect to a user-specified origin are required for all sources. Universal Transverse Mercator coordinates may be used to define source locations. A plant layout drawn to scale is required to obtain coordinates and building dimensions to the nearest meter.

Particle size resolution - Required if settling and deposition are to be considered. Deposition is generally only important for particles greater than 20 micrometers in diameter. The PM_{10} fraction could thus be treated as a lump sum without any need for particle size data although ISC allows input of up to 11 size fractions.

Chemical composition data - None required.

TABLE 5-4

CLIMATOLOGICAL DISPERSION MODEL (CDM 2.0)[3,4]

Type - Dispersion.

Application - Estimating urban scale impact of multiple point and area sources distributed over a square grid system. Line sources are handled as area sources.

Short/long term - Long term (seasonal/annual)

Inventory area - All sources within the boundaries of the grid system must be inventoried.

Stack and exhaust data - Physical stack height and inside diameter, exhaust gas exit velocity, and temperature are needed to calculate plume rise.

Nonpoint source configuration - Area source emissions are allocated to square grid cells. The coordinates of the southwest corner and the width of each grid are required. Stack height (if applicable) is also required.

Temporal resolution of the model output - Seasonal or annual average concentrations are predicted by the model.

Actual emission units input to model - grams/second. Also required are ratios of average daytime and nighttime emission rates to the 24-hour average.

Spatial resolution of source data - The scale of the coordinate system for locating sources is completely arbitrary. Area source grid squares can be defined arbitrarily small; however, since the program will only handle 2500 grid squares, a tradeoff exists between area source resolution and model coverage. Since CDM 2.0 operates on the implicit assumption that area source emissions are relatively uniform, grid square sizes should not be selected that are too small. Grid squares of varying sizes are allowed, but their side length must be an integer multiple of a common side length.

Particle size resolution - No particle size resolution below 10 microns is required. The PM_{10} fraction can be treated as a single lump sum.

Chemical composition data - None required.

Other - An assumed pollutant half life, may be entered into CDM 2.0, but should not be considered in PM_{10} SIP's.

TABLE 5-5

RAM[5]

Type - Dispersion

Application - Estimating urban scale impact of multiple point and area sources distributed over a square grid system. Line sources are handled as area sources.

Short/long term - The RAM is a sequential model designed to process hourly inputs. The RAM calculates concentrations for 1, 2, 3, 4, 6, 8, 12 and 24 hourly averages. The RAM may be run for each hour of a year or by averaging all 24-hour concentrations.

Inventory area - All sources within the boundaries of the grid system must be inventoried.

Stack and exhaust data - Stack height and inside diameter, stack gas exit temperature, and velocity are needed for plume rise calculations.

Nonpoint source configurations - Area source emissions are allocated to square grid cells. The coordinates of the southwest corner and the side length of each grid are required. Height of emissions is also needed, if applicable.

Temporal resolution of model output - One hour to 1 day (24-hour) average concentrations are calculated by RAM, and annual averages are calculated by averaging all 24-hour concentrations.

Actual emission units input to model - grams/second for both point and area sources.

Spatial resolution of source data - The scale of the coordinate system is completely arbitrary, allowing any level of resolution.

Particle size resolution - No particle size resolution below 10 microns is required. The PM_{10} fraction can be treated as a single lump sum.

Chemical composition data - None required.

Other - An assumed pollutant half life may be entered into RAM, but should not be considered in PM_{10} SIP's.

TABLE 5-6

SINGLE SOURCE (CRSTER) MODEL[6]

Type - Dispersion.

Application - Estimating local impact of a single stack or up to 19 sources considered to be emitting at a single point in rural or urban areas where terrain is below physical stack height.

Short/long-term - The basic estimate is for a 1-hour period; multiples up to 24 hours may be selected and the annual mean concentration is calculated from the average of all hourly concentrations.

Inventory area - No area, per se, is included in the inventory, because the single stack or collection of stacks are considered to be emitted at a common point.

Stack and exhaust data - Physical stack height and inside diameter, exhaust gas exit velocity, and temperature are needed to calculate plume rise.

Nonpoint source configurations - CRSTER does not handle nonpoint sources.

Temporal resolution of model output - The model calculates 1-hour, 3-hour, 24-hour, and annual mean concentrations. Optional averaging times of 2, 4, 6, 8 or 12 hours may be selected.

Actual emission units input to model - grams/second.

Spatial resolution of source data - None; all sources are considered to emit from the same point.

Particle size resolution - No particle size resolution below 10 microns is required. The PM_{10} fraction can be treated as a single lump sum.

Chemical composition data - None required.

Other - An assumed pollutant half life may be entered into CRSTER, but should not be considered in PM_{10} SIP's.

TABLE 5-7

MULTIPLE POINT SOURCE MODEL WITH TERRAIN ADJUSTMENT (MPTER)[7]

Type - Dispersion.

Application - Estimating local impact of a number of point sources in rural or urban areas where terrain is below physical stack height.

Short/long term - Short-term (1-24 hours) and annual calculations can be made.

Inventory area - That area including all of the point sources (up to 250) that are being modeled.

Stack and exhaust data - For each stack, physical stack height and inside diameter, stack gas temperature and exit velocity, and stack ground level elevation are needed to calculate plume rise.

Nonpoint source configuration - MPTER does not handle nonpoint sources.

Temporal resolution of model output - One hour or any multiple thereof, including hour-by-hour concentrations for an annual average.

Actual emission units input to model - grams/second for each point source.

Spatial resolution of source data - The scale of the point source coordinate system is arbitrary, allowing any level of resolution.

Particle size resolution - No particle size resolution below 10 microns is required. The PM_{10} fraction can be treated as a single lump sum.

Chemical composition data - None required.

Other - An assumed pollutant half life may be entered, but should not be considered in PM_{10} SIP's.

5.4 Inventory Data Needed in Receptor Models

The considerations in sections 5.2 and 5.3 apply primarily to PM_{10} inventories developed for use in dispersion models. Different source and emissions data are required in receptor models. As discussed in section 4.0, receptor models use techniques to estimate the contributions of emission sources based on specific characteristics of particulate matter measured at various receptor sites. Receptor models should be used together with rollback procedures or dispersion models to define source/receptor relationships.

Because of the nature of receptor models, emission factors and mass emission estimates are not needed as input as they are for dispersion models. Nor, generally, are detailed source data required such as activity levels and control techniques.* The only source emission data that are needed for direct use in receptor models involve similar kinds of morphological or chemical characterizations of emissions that are made on the ambient samples collected at the receptor site(s). Moreover, such emission characterizations are usually not obtained for each individual source within an area being modeled, but typically are representative of broad classes of sources whose particle compositions are similar (e.g., motor vehicles, oil fired boilers, etc.).

The major type of receptor model utilizes various chemical methods.[16,17] In general, chemical methods identify source contributions by comparing the relative amounts and temporal variability of various chemical species at ambient sampling sites with source chemical patterns (i.e., "fingerprints").

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*Note that while detailed source and emissions data on individual facilities are not required to run receptor models, these kinds of data are needed in interpreting the results and in defining specific source/receptor relationships.

Chemical methods are comprised of mass balance techniques, which identify the most probable combinations of sources to explain the chemical pattern on a single filter, and multi sample methods (including factor analysis), which identify the most probable linear combination of sources to explain either the time or spatial variability in ambient chemical patterns.

Microscopy represents another important type of receptor method typically used to confirm the results obtained from chemical methods. Optical microscopy relies on identification of particles collected at the receptor site by their size, shape, color, surface properties and birefringence (an optical property). Scanning electron microscopy, commonly automated by computer and supplemented with x-ray fluorescence analysis, relies on a particle-by-particle analysis of particle size, shape, and elemental composition. The use of such particle identification techniques requires a knowledge of the physical characteristices (e.g. shape, size, brightness, color) of particles from various source categories or access to references that catalog particle size characteristics from various sources.[16,18,19]

Since nearly all receptor models require a knowledge of the chemistry or morphology of source emissions, the development of a collection of emission chemistry data or particle reference samples (or both) is often required. Such data may be compiled from the literature (e.g., previous receptor model applications); however, experience has demonstrated the value of developing locale-specific emission characterizations, especially for more important source categories.

The EPA has compiled a library of chemical and elemental composition data that will provide a common basis for receptor model source characterizations.[20] An example of the types of data in this library is shown in Table 5-8.

TABLE 5- 8

EXAMPLE OF DATA IN EPA'S PARTICULATE SOURCE LIBRARY (20)

SOURCE: STEEL PRODUCTION - OPEN HEARTH FURNANCE
SCC: 3-03-009-01
CONTROLS: ESP

PROFILE: 28302
RANKING: 2121
RATING : D

SPECIES NUMBER	SPECIES NAME	FINE <2.5 UM % BY WT	FINE <2.5 UM +-	FINE <2.5 UM UNC	COARSE 2.5-10UM % BY WT	COARSE 2.5-10UM +-	COARSE 2.5-10UM UNC	TSP <30 UM % BY WT	TSP <30 UM +-	TSP <30 UM UNC
4	BE	NA	+ -	NR	NA	+ -	NR	NA	+ -	NR
5	B	NA	+ -	NR	NA	+ -	NR	NA	+ -	NR
9	F	NA	+ -	NR	NA	+ -	NR	NA	+ -	NR
11	NA	NA	+ -	NR	NA	+ -	NR	NA	+ -	NR
12	MG	NR	+ -	NR	NR	+ -	NR	NR	+ -	NR
13	AL	NR	+ -	NR	NR	+ -	NR	NR	+ -	NR
14	SI	NR	+ -	NR	NR	+ -	NR	NR	+ -	NR
15	P	<	+ -	NR	<	+ -	NR	<	+ -	NR
16	S	13.300	+ -	NR	3.000	+ -	NR	13.300	+ -	NR
17	CL	<	+ -	NR	<	+ -	NR	<	+ -	NR
19	K	5.000	+ -	NR	5.000	+ -	NR	5.000	+ -	NR
20	CA	0.550	+ -	NR	0.550	+ -	NR	0.550	+ -	NR
21	SC	<	+ -	NR	<	+ -	NR	<	+ -	NR
22	TI	<	+ -	NR	<	+ -	NR	<	+ -	NR
23	V	0.550	+ -	NR	0.550	+ -	NR	0.550	+ -	NR
24	CR	2.000	+ -	NR	0.550	+ -	NR	2.000	+ -	NR
25	MN	0.550	+ -	NR	0.550	+ -	NR	0.550	+ -	NR
26	FE	11.000	+ -	NR	16.000	+ -	NR	11.000	+ -	NR
27	CO	<	+ -	NR	<	+ -	NR	<	+ -	NR
28	NI	0.550	+ -	NR	0.550	+ -	NR	0.550	+ -	NR
29	CU	0.550	+ -	NR	0.550	+ -	NR	0.550	+ -	NR
30	ZN	<	+ -	NR	<	+ -	NR	<	+ -	NR
31	GA	<	+ -	NR	<	+ -	NR	<	+ -	NR
32	GE	<	+ -	NR	<	+ -	NR	<	+ -	NR
33	AS	0.050	+ -	NR	0.050	+ -	NR	0.050	+ -	NR
34	SE	<	+ -	NR	<	+ -	NR	<	+ -	NR
35	BR	0.050	+ -	NR	0.050	+ -	NR	0.050	+ -	NR
37	RB	0.050	+ -	NR	0.050	+ -	NR	0.050	+ -	NR
38	SR	<	+ -	NR	<	+ -	NR	<	+ -	NR
40	ZR	<	+ -	NR	<	+ -	NR	<	+ -	NR
47	AG	0.050	+ -	NR	0.050	+ -	NR	0.050	+ -	NR
48	CD	0.050	+ -	NR	0.050	+ -	NR	0.050	+ -	NR
50	SN	0.050	+ -	NR	0.050	+ -	NR	0.050	+ -	NR
51	SB	0.050	+ -	NR	0.050	+ -	NR	0.050	+ -	NR
55	CS	<	+ -	NR	<	+ -	NR	<	+ -	NR
56	BA	<	+ -	NR	<	+ -	NR	<	+ -	NR
58	CE	<	+ -	NR	<	+ -	NR	<	+ -	NR
80	HG	<	+ -	NR	<	+ -	NR	<	+ -	NR
82	PB	0.550	+ -	NR	0.550	+ -	NR	0.550	+ -	NR
201	OC	NA	+ -	NR	NA	+ -	NR	NA	+ -	NR
202	EC	NA	+ -	NR	NA	+ -	NR	NA	+ -	NR
203	SO4	40.000	+ -	NR	35.000	+ -	NR	40.000	+ -	NR
204	NO3	0.550	+ -	NR	0.550	+ -	NR	0.550	+ -	NR
SUM(%)		62.200			60.750			62.200		

NOTES: OC = ORGANIC CARBON : EC = ELEMENTAL CARBON : NA = NOT ANALYZED : NR = NOT REPORTED
< = LESS THAN DETECTION LIMIT
OTHER NOTES : 20% CARBON, 22-26% OTHER (SI, OZ, AL, MG) TSP AND COARSE. REF, 20

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These data are most useful in the chemical methods such as the mass balance model and factor analysis described in Appendix A of this guideline. For more information on this particulate matter source composition library, contact the U.S. Environmental Protection Agency, Air Management Technology Branch, MD-15, Research Triangle Park, North Carolina, 27711. The appropriate references cited in section 4.0 and Appendix A may be consulted for more details on the specific characterizations needed for each type of receptor model.

5.5 Condensable Particulate Matter

Condensable particulate matter (or condensed particulate matter, as it is synonymously described) can be broadly defined as material that is not particulate matter at stack conditions but which condenses and/or reacts (upon cooling and dilution in the ambient air) to form particulate matter immediately after discharge from the stack. Condensable particulate matter is of potential importance because it usually is quite fine and thus falls primarily within the PM_{10} fraction.[21] Sources suspected of emitting significant amounts of condensable material are shown in Table 5-9.

Condensable particle factors, as such, are not explicitly included in AP-42 for most source categories. To the extent that EPA's Method 5 (Reference 22) captures a portion of the condensable fraction, AP-42 particulate matter factors for certain categories that are currently based on Method 5 include some condensable particles. Some condensable particulate matter will also be collected by the testing procedures outlined in Appendix C of this guideline.

5.6 Secondary Particulate Matter

Secondary particulate matter can be broadly defined as particles that form through chemical reactions in the ambient air well after dilution and condensation have occurred. An example of this phenomenon is the formation of

TABLE 5-9

POTENTIAL SOURCES OF CONDENSABLE PARTICULATE MATTER[21]

Stationary Sources

- Alfalfa Dryers
- Anode Baking Furnaces
- Asphalt Plants
- Asphalt Roofing
  - felt saturating
  - asphalt blowing
- Boilers/Other Combustion
  - bagasse
  - coal
  - lignite
  - oil
  - wood/bark
- Charcoal Kilns
- Chemical Production
  - boric acid
  - phosphoric acid
  - potassium still
  - zinc sulfate
- Citrus Peel Dryers
- Coke Plants
- Corn Processing
  - wet milling
  - syrup manufacturing
- Elemental Phosphorus
  - electric arc furnace
- Expanded Vinyl
- Ferroalloy Mills
- Fertilizer Plants
  - ammonium nitrate
  - diammonium phosphate
- Fiberboard
  - dryer
  - press
- Glass Fiber and Mineral Wool
  - curing ovens
  - blow chambers
- Glass Plants
- Grain Dryers
- Iron and Steel Mills
  - sinter plant
  - electric arc furnace
  - basic oxygen furnace
  - open hearth furnace
  - heat treating
  - scrap steel melting
- Gray Iron Foundries
- Kraft Pulp and Paper Mills
  - recovery boilers
  - lime kiln
  - smelt dissolve tank
  - blow tank/hot water accumulator
- Lime Kiln
- Manure Dryers
- Mineral Products
  - gypsum
  - clay dryers
  - feldspar dryers
  - clay kilns
- Municipal Incinerators

TABLE 5-9 (CONTINUED)

- Petroleum Refineries
    - FCC
    - catalytic regenerator
    - heaters
    - petroleum coke

- Portland Cement Plants
    - kiln
    - finish mill

- Primary Nonferrous Smelters
    - Cu converter
    - Cu electric furnace
    - Cu fluid bed roaster
    - Cu sinter line
    - Pb sinter line
    - Pb blast furnace
    - Mo roaster
    - Zn ore briquet dryer
    - Zn sweat kiln
    - Zn fume kiln

- Residential Heating
    - oil
    - wood

- Secondary Metal Smelters
    - Al scrap furnace
    - Al dross furnace
    - brass and bronze furnaces
    - copper furnace
    - Pb furnaces
    - PbO_2 mills
    - Pb grid casting
    - Pb remelt pot
    - other metal furnaces

Mobile Sources

- All Mobile Sources

- Sewage Sludge Incinerator

- Silicon Carbide Furnaces

- Spray Paint Booths

- Sulfite Pulp Mill
    - recovery boiler
    - blow tanks

- Rubber Incineration

- Rubber Curing Press

- Textile
    - nylon polymerization
    - melt polymer spinning
    - tenter frame
    - dye beck
    - heat set
    - texturizing
    - latex backing

- Tire Buffing Operations

- Wood Products
    - veneer plant dryer
    - resawing

sulfate particles in a plume from the oxidation of sulfur dioxide by one of several atmospheric transformation mechanisms. Generally, secondary particulate matter can be distinguished from condensable particulate matter by the time and/or distance downwind from the stack required for formation. Condensable particles form in a matter of seconds in the stack exhaust due primarily to immediate cooling and air dilution whereas secondary transformation requires minutes, hours, or even days.

Unlike condensable particulate matter, secondary particulate matter should not be included in the PM_{10} inventory as if directly emitted as particles. Condensable particulate matter, because it forms so quickly, will likely impact on any nearby receptor, and thus can be treated as if it were emitted as particulate matter. Secondary particle formation, conversely, is a function of time and distance downwind from the source, as well as chemical composition and reactivity. Since secondary particle formation is an atmospheric phenomenon, it should be simulated by an air quality model if it is considered to be an important component of ambient PM_{10} concentrations. Precursors of secondary particles especially SO_x and NO_x, need to be included in the inventory when such models are used.

5.7 Use of Existing Emission Inventory

An important consideration when planning a PM_{10} inventory is whether an existing particulate matter inventory can be used as a foundation or starting point. Since many areas have compiled annual, countywide inventories of particulate matter (e.g., for previous SIPs or for submission into EPA's NEDS or Compliance Data System), an incentive exists for building on such inventories rather than compiling new ones altogether. If an existing inventory is comprehensive, current, and accurate, much of the source data needed in the PM_{10} inventory is already available.

The utility of the existing inventory depends on the particular air quality model employed. In some instances, a conventional inventory of annual, countywide particulate matter emissions will provide most of the needed information. Actually, the terms "annual" and "countywide" do not give a complete picture of the resolution commonly inherent in this kind of inventory, at least for point sources. First, while the emissions are typically expressed in units of tons per year, the available operating pattern information for each point source generally allows the user to extrapolate emissions for a given season, workday, and even for a given hour during a workday. Details on performing this kind of temporal apportionment are given in Chapter 6 of Reference 18.

Second, stack data are available for point sources in the annual, countywide inventory that are sufficient for many PM_{10} modeling applications. Specifically present are stack heights, diameters, flow rates, and plume heights, which are the major stack and exhaust gas parameters commonly needed by most applicable dispersion models. (Note: Some models also require exit gas velocities, but flow rates can be easily converted to exit velocities by dividing by the cross sectional area of the stack.) Moreover, the location of each stack is commonly specified to the nearest tenth kilometer, providing acceptable spatial resolution for applications where the grid system will be comprised of relatively large grid cells.

Thus, relating back to the inventory specifications for each model outlined in Tables 5-3 through 5-7, it can be seen that, for point sources at least, conventional inventories of particulate matter may provide sufficient temporal and spatial resolution and stack data for a number of dispersion models such as CDM 2.0, RAM, CRSTER, and MPTER.

The area source data available from conventional (i.e., annual, countywide) particulate matter inventories can also be useful in some PM_{10} modeling applications; however, additional data manipulation is generally needed to develop the requisite temporal and spatial resolution. First, most existing area source records do not include operating rate data comparable to those included in the point source record. Hence, to develop emissions estimates for a period of time less than a year, the user must impose an operating pattern for each source category. Detailed operating patterns for many important area source categories are suggested in Chapter 6 of Reference 18 along with recommendations for employing them.

Probably the most difficult aspect of using conventional area source data in a PM_{10} inventory is that for certain applications, the emission totals must be allocated from the county level to the grid cell level. This is generally done by assuming that the distribution of a given area source activity behaves similarly to some surrogate indicator (e.g., population) whose distribution is known at the subcounty level. For example, emissions from residential fuel combustion might logically be apportioned according to the distribution of dwelling units. More specifics on gridding countywide emissions are given in Chapter 6 of Reference 18.

Referring to the inventory specifications in Tables 5-3 through 5-7, the only models which could use the typical existing area source inventory as primary input are CDM 2.0 and RAM. The other models either do not handle area sources or else require more detailed information.

Several models require such specific inventory data on individual sources or source complexes that an existing inventory may be of little use at all. The ISC, for example, requires input on the dimensions and juxtaposition of buildings near each stack in order to consider the aerodynamic wake effects on plumes. The ISC also requires finer spatial resolution than is typically available. Receptor models are probably most unique in terms of their input requirements. Generally, the location of sources, stack and exhaust data, and even the rates of emissions are not required by receptor models. As an example, the only inventory data needed by the Mass Balance (MB) model are the chemical or elemental composition of emissions for each source category as a function of particle size (i.e., in the <2.5 micrometer and $\geq$2.5 to 10 micrometer size ranges). Particle size, shape, and composition data will not be contained in most inventories that have been developed for dispersion modeling applications.

In any case, whenever an existing particulate matter inventory is being used to directly generate the PM_{10} inventory, total particulate matter emissions have to be converted to PM_{10} emissions. As was discussed in section 5.2, the easiest way to accomplish this is to multiply existing particulate matter estimates by appropriate PM_{10} fractional multipliers. For maximum accuracy, PM_{10} fractions should be applied to individual sources rather than aggregated source categories and should account for the existence of any emission controls. Alternatively, instead of applying PM_{10} fractions, PM_{10} emission totals can be calculated by applying the appropriate PM_{10} emission factor to the existing activity level for each source.

5.8 Data Handling

An important consideration in any inventory compilation effort is the potential need to develop special data handling software. In a number of models, data handling can be readily accomplished manually because the input requirements are meager. For certain models, however, computerized data handling capabilities may be desirable to compile and properly format the large quantity of inventory data needed to drive the models.

As a general rule, the amount of inventory data that must be handled is directly proportional to the number of sources being modeled. Hence, for the single source models such as CRSTER, manually preparing the input data in the necessary formats should present no problems. The same will be true for models like ISC and MPTER if only a few sources are considered.

The primary applications where computerized data handling will prove essential are (1) when dealing with hundreds of point sources; (2) where area source emissions must be subcounty allocated to grid cells; (3) when numerous line sources must be considered individually; and (4) where an existing particulate matter inventory is being converted to a PM_{10} inventory, necessitating a number of preprocessing computations.

Computerized data handling is desirable when preparing PM_{10} inventories for input to CDM 2.0, RAM and MB, as well as MPTER if large numbers of sources are considered. The CDM 2.0 and RAM are most likely to be applied to large, urban scale applications involving many point and area sources and large grid systems. Moreover, existing particulate matter inventories are most likely to be utilized as input for these two models, necessitating some preprocessing to convert total particulate matter to PM_{10}. Hence, if either CDM 2.0 or RAM is to be employed for PM_{10} modeling, and if an existing annual, countywide inventory will be used to provide the necessary input, sufficient resources should be reserved for developing and running an auxiliary data handling system that will facilitate timely processing of the input data. Data handling is frequently an overlooked aspect of inventory compilation and air quality simulation modeling that can consume a great deal of resources. Thus, the inventory specialist, modeler, and programmer should all be involved in the planning of this kind of PM_{10} inventory effort.

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6.0 DEVELOPMENT OF CONTROL STRATEGIES

6.1 Overview

This section identifies general approaches with respect to the use of ambient measurements and model estimates in determining the level of control needed to demonstrate attainment of PM_{10} NAAQS. Conceptually, this involves determining the PM_{10} design concentration for a particular site or receptor that must be reduced to the level of the NAAQS, thereby assuring attainment. These design concentrations are used to determine the level of control needed. The guidance contained in this section focuses on particulate matter in the specific size fraction, PM_{10}, although it may be applied to particulate matter in general as a surrogate where PM_{10} data bases are inadequate.

In all cases where PM_{10} ambient concentrations estimated by a dispersion model are used, the design concentration is assumed to be the sum of concentrations contributed by the source(s) and an appropriate background concentration. With the PM_{10} annual and 24-hour NAAQS, two separate design concentrations, one for each standard, are needed per site. Attainment of the annual NAAQS requires that the expected annual PM_{10} concentration be less than or equal to the level of the NAAQS. Attainment of the 24-hour NAAQS requires that the expected number of exceedances of the NAAQS be less than or equal to one per year.

The SIP-related emission limits should be based on the NAAQS (annual or 24-hour) which result in the most stringent control requirements. For example, if the annual NAAQS requires more stringent control requirements than the 24-hour NAAQS, the annual NAAQS is considered the more restrictive standard and the corresponding emission limit(s) would be adopted.

6.2 Data Base Requirements

The design concentrations for attainment of the 24-hour PM_{10} NAAQS can be based on ambient measurements of PM_{10}, or model estimates of ambient concentrations at individual sites during 1 or more years of stable emissions conditions. Ideally, (1) modeling estimates using 5 years of National Weather Service meteorological data (or at least 1 year of on-site data), or (2) 3 years of representative air quality measurements should be considered in determining 24-hour design concentrations. If more years of data with relatively unchanging emissions are available, they also may be considered in calculating design concentrations. The more years of data available, the more stable the estimate of PM_{10} design concentrations.

The preferred approach for estimating a design value is through the use of an applicable dispersion model corroborated by receptor models, any available TSP data (using Appendix B), and any available PM_{10} data. If there is no applicable dispersion model and at least 1 complete year of PM_{10} data are available,* the PM_{10} data would be used to estimate the design value; if the PM_{10} data are insufficient,* the design value would be based on Appendix B of this guideline and corroborated by the available PM_{10} data.

6.3 Methodologies for Determining Design Concentrations

The annual design concentration is the expected annual arithmetic mean determined by the approach discussed in Appendix K, of Part 50. In the simplest case, the design concentration can be determined by averaging 3 years of monitored or 5 years of modeled PM_{10} concentrations.

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*These data should meet first year sampling requirements found in CFR 58.13.

There are several acceptable approaches for determining appropriate 24-hour PM_{10} design concentrations. These approaches which are described in the next sections are based on monitored or modeled PM_{10} concentrations. They include: (1) a table look-up procedure; (2) fitting a statistical distribution; (3) graphical estimation; and (4) the use of conditional probabilities. Each of these approaches and corresponding data usage requirements are presented in detail in the ozone guideline.[1] The following sections briefly summarize each of these approaches and indicate how the technique may be applied for determining PM_{10} concentrations.

6.3.1 Table look-up

The 24-hour PM_{10} design concentration is influenced primarily by the few highest measured or estimated concentrations at a site. Availability of the highest concentrations makes it possible to construct a simple table look-up procedure to determine the design concentration. All portions of the year should be adequately reflected in the measurements.

To use the tabular approach for the 24-hour PM_{10} standard, it is necessary to know the total number of 24-hour PM_{10} concentrations at the site and then select the design value from among the highest concentrations. The number of available 24-hour concentrations determines which of the highest concentrations is chosen as the design concentration. For example, if a comprehensive monitoring program provides 1,095 24-hour concentration measurements (or 3 full years of data) at a site, then the ranks of the lower and upper bounds obtained from Table 6.1 are 4 and 3 respectively. This means that an appropriate design concentration for that site would be between the fourth-highest and third-highest concentrations. In using this table, the lower of the two concentrations should be used as the design concentration, i.e., the fourth-highest concentration. Therefore, in this example, it suffices to know only the four highest values during the time period. With multiple monitoring sites, the highest PM_{10} concentrations at each site would have to be considered and a design concentration established for each location. For example, the "controlling" design concentration for an area with seven sites, each having 1,095 values, would be the highest of the seven fourth-highest values.

For routine model applications with 5 full years of 24-hour concentration estimates, the PM_{10} design concentration of critical interest becomes the highest of sixth-highest concentrations for the entire receptor network.

The look-up procedure is basically a tabular technique for determining what point on the empirical frequency distribution corresponds to a frequency of 1/365. By construction, the table look-up procedure tends to provide a design concentration slightly lower than would be derived using a continuous curve representing a theoretical frequency distribution for PM_{10} values. For example, use of the table-derived estimate might be modified by interpolation between the

TABLE 6-1

TABULAR ESTIMATION OF PM_{10} DESIGN CONCENTRATIONS

Number of Daily Values	Rank of Upper Bound	Rank of Lower Bound	Data Point Used for Design Concentration
$\leq$ 347	-	1	Highest Value
348 - 695	1	2	Second Highest Value
696 - 1042	2	3	Third Highest Value
1043 - 1096	3	4	Fourth Highest Value

third- and fourth-highest values. However, this adds an additional element of calculation. Nevertheless, if a more precise design concentration should be desirable, the use of interpolation formulas (Section 6.3.2) or more simple graphical procedures (Section 6.3.3) may be necessary.

For the cases which are limited to less than a complete year of data, (i.e., 365 observations) the maximum concentration must generally be used as a tentative design value. In this case it should be recognized that the maximum concentration generally represents a lower-bound estimate for the true design concentration. In order to provide an alternative higher estimate for the design concentration, the extrapolated value derived from a fitted distribution (Section 6.3.2) can be used.* With sparse data sets, the tentative design concentrations defined as the maximum concentration or the extrapolated concentration are quite likely to require further revision as more data become available. In addition, the failure to adequately account for yearly variations in meteorological conditions makes any estimate based on a single year of data very tentative.

6.3.2 Fitting one statistical distribution to several years of data

With several years of fairly complete PM_{10} 24-hour air quality measurements or model estimates, a statistical distribution could be selected that "fits" the data. Information on fitting statistical distributions can be found on pages 18-20 in the ozone guideline.[1,2,3] Because we are interested in peak concentrations, emphasis would be placed on the top

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*An extrapolated value must be used, however, instead of the maximum observed concentration in order to evaluate the possibility that the 24-hour standard is controlling, using procedures described in Sections 6.3.2 - 6.3.4.

5 to 10 percent of the concentrations. This approach, at least conceptually, provides a more stable estimate of the design concentration; but it also involves additional computations and interpretation.

Criteria for judging reasonable fit are also given in the ozone guideline. The design concentration corresponds to a frequency of 1/365. In some cases the available data will fall in this frequency range. In such cases, the fitted distribution should be consistent with the data in this range. With adequate data, there will be concentration data points on either side of the design frequency, data which can be used as a constraint in fitting the distribution.

When less concentration data are available, i.e., infrequent air quality measurements, it may not be possible to "bound" the design concentration. For example, if there are no measured values on the empirical frequency distribution with frequencies less than 1/365, the estimated design concentration will represent an extrapolated concentration. This extrapolated design concentration will be higher than the maximum observed or estimated (via air quality model) value. When this is the case, caution should be exercised in the use of the extrapolated value.

6.3.3 Using the empirical frequency distribution of several years of data (graphical estimation)

With sufficient data it may not be necessary to fit a statistical distribution, as discussed in Section 6.3.2. The concentration value corresponding to a frequency of 1/365 may be read directly off a graph of the empirical distribution and used as the design concentration. The description of this approach is given on pages 25 and 34 in the ozone guideline.

6.3.4 Conditional probability approach

While the previous methods required grouping concentration data from several years, this approach allows individual years of data to be treated separately. This is done by fitting a separate statistical distribution to each year of data and assuming a given probability that each year will reoccur. This approach is of interest when different importance should be placed on the individual years in terms of meteorological conditions or sampling completeness. For this reason, this approach may also be of interest for the annual standard. The conditional probability approach is somewhat theoretical in nature, but is adequately discussed in the ozone guideline.

6.4 Determining Emission Limits

6.4.1 General

Once PM_{10} design concentrations have been established through the use of air quality measurements or model estimates, a proportioning method can be used at each site to estimate control requirements for SIP development. This proportioning method differs from simple rollback in that the source contributions are determined from receptor or dispersion modeling and not directly from the emissions as in simple rollback. Nevertheless, the method conceptually considers that the total reduction (TR) in pollutant concentration should be:

$$TR\ (ug/m^3) = PM_{10}\ \text{Design Concentration} - PM_{10}\ \text{NAAQS}$$

If a design concentration is greater than the NAAQS (TR is positive), a reduction in PM_{10} emissions is required. This might be accomplished by reducing the contribution of a single source or it may require reduction in several individual sources or source categories so that

$$TR\ (ug/m^3) = {}^{S}ISR_i\ (ug/m^3)$$

where ISR_i is the Individual Source Reduction desired from a source or source category i.

These ISR's are generally selected based on many considerations, including the technical feasibility of achieving a given emission reduction or additional reduction at that source. The percent reduction in emissions (%RE) for a source or source category is given by

$$\%RE_i = \frac{ISR_i\ (ug/m^3)}{AC_i\ (ug/m^3)}$$

where AC is the ambient concentration due to the individual source (i) or source category as determined through a model.

The SIP must demonstrate that the control requirements will be adequate to meet the NAAQS under other situations where the relative source contributions may be different from that on the design day. This is discussed further in Section 6.4.3. If receptor models are used to determine the relative source contributions, the operating rates of the sources over the time period studied must be evaluated. If they are inappropriate for the SIP development, the source contributions should be adjusted proportionally.

6.4.2 Example for annual averages

Assume for discussion that the annual NAAQS for PM_{10} is 75 ug/m^3 and that the site with the "controlling" annual design concentration for the area is 100 ug/m^3. Then the total required reduction for the area would be:

$$TR = 100 - 75 = 25\ ug/m^3.$$

Next, for the site of the most restrictive design concentration, consider the following source contributions estimated by a receptor or a dispersion model:

Source	Source Category Contributions to Ambient Conc. (AC)
Steel mill roads	15 ug/m^3
Steel mill coke ovens	10 ug/m^3
Coal storage pile	5 ug/m^3
Urban paved roads	20 ug/m^3
Cement plant	10 ug/m^3
Background	40 ug/m^3
	100 ug/m^3

The TR would be the sums of the individual reductions in ambient concentration. Assume that the following reductions in source concentration are selected for consideration:

Source	Individual Source Reduction (ISR)
Steel mill roads	8 ug/m^3
Steel mill coke ovens	5 ug/m^3
Cement plant	8 ug/m^3
Coal storage pile	4 ug/m^3
TR =	25 ug/m^3

Since the TR sums to 25 ug/m^3, it is assumed that the individual source reductions, if implemented, would reduce the annual PM_{10} concentration at this "controlling site" to 75 ug/m^3. The required emission reductions (%RE) to accomplish this are calculated for each source category. For example:

$$\%RE_{cement} = \frac{ISR_{cement}}{AC_{cement}} = \frac{8}{10} = 80\%;$$

so that control requirements would be 80 percent for the cement plant. It is assumed that the selected emission reductions will allow the NAAQS to be met at the "controlling site," as well as all other monitoring or receptor sites. This assumption should be tested by reversing this procedure and determining whether the anticipated reduction impacts on other sites above the standard will result in attainment at those sites. If this is not found to be true, which is more likely in multisource situations than areas affected by a small number of sources, individual design concentrations at other sites will have to be considered and the emission reductions reassessed. In such cases, the control strategy will be composed of the maximum of each of the individual source reductions calculated across the network.

For the proportioning method discussed here, the background concentration should be estimated as that portion of the concentration which is not attributed to the sources being investigated. This estimate should be based on actual observations in nonurban areas near the boundary of the area or on model estimates of the actual impact of the sources not under investigation.

6.4.3 Considerations for 24-hour averages

An approach similar to that discussed in the above section can be employed to determine control requirements for the 24-hour standard. The PM_{10} design concentrations and individual source contributions for each site, as well as background concentrations, must be available. However, for short-term averages (e.g., 24-hour), it is likely that a single high concentration is dominated by relatively few sources with source contributions varying with meteorological conditions. Thus identification of emission limits that assure the short-term 24-hour NAAQS will be met at all sites is likely to require an iterative and perhaps lengthy process. This is especially true of multisource areas.

An alternative is to develop control strategies with emission limits specified for each source category, perhaps based on a preliminary application of the modified rollback model. The strategies would then be tested with a dispersion model to determine if the NAAQS are met everywhere. Those strategies that allow the NAAQS to be met would be identified for further consideration in preparing a set of preferred emission limitations. This alternative, too, could involve an iterative procedure. However, it provides a means by which factors such as the best technological, most cost effective, and most enforceable set of emission controls can be considered. Such a procedure might also be employed for annual concentrations, especially where many receptor sites are of concern.

Reference

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7.0 SIP REQUIREMENTS AND DATA REPORTING

7.1 Introduction

This section describes the requirements for SIP revisions in the Act, EPA's PM_{10} SIP development policy, the interface between PM_{10} and TSP control strategies, and summarizes how PM_{10} emissions data should be reported to EPA's data bank. To develop an acceptable control strategy as required for a PM_{10} SIP, a State can utilize the information summarized in section 4.0 of this document for carrying out appropriate modeling, the information in section 5.0 to develop an emissions inventory for model inputs, and the information in section 6.0 for developing control strategies.

7.2 Clean Air Act Requirements

7.2.1 Time limits, SIP requirements

Section 110(a) of the Act requires every State to submit to EPA a SIP which provides for implementation, maintenance, and enforcement of each NAAQS in each air quality control region within the State. The SIP is required to be submitted within 9 months of the promulgation of a new NAAQS or the revision of existing NAAQS. The SIP must provide for attaining a primary NAAQS as expeditiously as practicable, but no later than 3 years after SIP approval by EPA. Up to an additional 2 years could be provided for attainment if the requirements in section 110(e) of the Act are met.

These section 110 requirements are applicable to PM_{10} NAAQS. The PM_{10} SIP's therefore are due within 9 months of promulgation of PM_{10} NAAQS and are to cover all areas of the State as qualified in section 2.4 of this document.

7.2.2 Regulations in 40 CFR Part 51

The regulations promulgated in Part 51 address the preparation, adoption, and submittal to EPA of SIP's for implementing the NAAQS. These regulations reflect the requirements set forth in the Act. Part 51 has recently been restructured to contain more subparts and sections to make it more organized and readable. That restructuring effort consisted only of deleting obsolete material and reorganizing the remaining material and no substantive changes were made to the regulatory requirements at that time. The Part 51 regulations still apply to PM_{10}.

7.3 PM_{10} SIP Development Policy

As discussed in section 7.2.1, the entire State must be covered by a PM_{10} SIP and the SIP is to be submitted within 9 months of the date the PM_{10} NAAQS are promulgated. However, because PM_{10} data are not available in all areas, EPA has placed areas into three groups. Section 2.4 of this document discusses grouping procedures. The requirements for PM_{10} SIP development are described in the following sections.

7.3.1 Group I PM_{10} SIP requirements

States are required to submit to EPA a revision to the particulate matter SIP within 9 months of promulgation of PM_{10} standards for Group I areas. The SIP revision must provide for attaining PM_{10} NAAQS as expeditiously as practicable, but no later than 3 years after the SIP is approved by EPA. The 3-year attainment deadline may be extended for up to 2 additional years by the Administrator if the conditions in section 110(e) of the Act are met. The submittal must include a modeled demonstration that provides for attainment and maintenance of the PM_{10}

standards. Portions of the SIP pertaining to prevention of significant deterioration/new source review section and air monitoring will also require revision.

The SIP must contain control measures sufficient to demonstrate attainment. Provisions for studies or demonstration projects of nontraditional particulate matter sources and measures necessary for attainment at a later date will not be acceptable as they were in the past for TSP standards.

7.3.2 Group II PM_{10} SIP requirements

States are also required to submit a SIP within 9 months of promulgation of PM_{10} standards for Group II areas. The States may submit a SIP for these areas as required for Group I areas, if they wish. Otherwise, States must submit a SIP which contains enforceable commitments to take the following actions.

(1) Gather ambient PM_{10} data, at least to an extent consistent with minimum EPA requirements and guidance (see subsections 3.2.3 and 3.2.5)

(2) Analyze and verify the ambient PM_{10} data and report 24-hour PM_{10} NAAQS exceedances to the appropriate Regional Office within 45 days of each exceedance.

(3) When an appropriate number of verifiable 24-hour NAAQS exceedances become available (see section 2.0) or when an annual arithmetic mean above the level of the annual PM_{10} NAAQS becomes available, acknowledge that a nonattainment problem exists and immediately notify the appropriate Regional Office.

(4) Within 30 days of the notification referred to in (3) above, or by the date 37 months after promulgation, whichever comes first, determine

whether the existing SIP will assure timely attainment and maintenance of the PM_{10} standards, and immediately notify the appropriate Regional Office.

(5) Within 6 months of the notification referred to in (4) above (if necessary), adopt and submit to EPA a PM_{10} control strategy that assures timely attainment and maintenance within a period of 3 years from approval of the committal SIP.

The following factors should be considered in determining the adequacy of the existing SIP in item (4) above:

(1) Air quality data. (Time is alloted for up to 3 years of PM_{10} data to be collected if a NAAQS is not violated sooner. At the end of that time, the available PM_{10} data must be examined to determine if attainment can be demonstrated in accordance with Appendix K of 40 CFR Part 50 or the Guideline on Exceptions to Data Requirements for Determining Attainment of Particulate Matter Standards in the absence of adequate PM_{10} data.)

(2) Emissions data. (The emission inventories must be evaluated to determine if emissions can increase significantly because actual emissions are far below allowable emissions for the area; determine if sources with operating permits are not operating or operating at reduced capacity and if "banked" emissions impact future air quality.)

(3) The present control strategy. (The existing control strategy should be evaluated to determine if it is fully implemented; if it is adequately enforced; start-up, shutdown, and malfunction

regulations are adequate to prevent circumvention of emission limits; and it can adequately attain and maintain the PM_{10} NAAQS if the above conditions are met. The evaluation should include the use of dispersion and receptor modeling techniques where appropriate).

The committal SIP must include an enforceable schedule with appropriate milestones or checkpoints. The EPA will review and act on both the committal SIP's and control strategies submitted under step (5). Also, revisions required in the PSD/NSR and air monitoring portions of the SIP must be submitted with the committal SIP.

7.3.3 Group III PM_{10} SIP requirements

For Group III areas, EPA will presume that the existing SIP is adequate to demonstrate attainment and maintenance of the PM_{10} standards. States are therefore only required to revise the PSD/NSR and air monitoring portions of their SIP's within 9 months.

7.4 SIP Content

A most important first step in developing a control strategy will be to inventory particulate matter sources and include all possible contributors. Receptor models applied to TSP samples, or PM_{10} samples if available, may be useful for this analysis as discussed in section 5 of this document. The State should include in its emission inventory point sources, fugitive emission points within industrial plants, plus all area sources such as unpaved and paved roads, unpaved parking lots, construction activity, open lots with no vegetative cover, woodstoves, agricultural activity, and similar sources. As previously stated, the option to study nontraditional sources and commit to implementing controls at a later date will no longer be acceptable. Information at the State level or from EPA-funded studies[1,2,3,4,5,6] should provide enough information to make determinations of which controls may be effective for these sources. In determining which controls to employ, the State should reassess existing control technology requirements for traditional sources, previously approved emission trades, and the effectiveness of startup, shutdown, and malfunction regulations.

7.5 Control Strategy Transition

Particulate matter emissions from most point sources and many area sources have been controlled as a result of SIP's to implement the former NAAQS for TSP. The regulatory requirements of an existing TSP SIP must remain in effect in accordance with section 110(i) of the Act, until a PM_{10} SIP is approved by EPA. Therefore, regulations in the existing SIP cannot be relaxed without a demonstration that the revision will not interfere with attainment or maintenance of the PM_{10} NAAQS. The existing regulations must continue to be enforced by Federal and State agencies during the period of transition from a TSP SIP to a PM_{10} SIP.

States will no doubt want to minimize any unnecessary disruption caused by going from these control programs to PM_{10} programs. Therefore, to the extent possible, States should utilize the existing control strategy in a TSP SIP as the basis for a PM_{10} program sufficient to attain and maintain the PM_{10} NAAQS. The EPA expects States to build on the current control strategies to whatever degree necessary to demonstrate attainment and maintenance of PM_{10} NAAQS. This may include adopting the current control strategy in full, if it can be shown to be sufficient for PM_{10} purposes, or adopting it in part.

7.6 Current Emission Regulations

Particulate matter SIP's contain emission regulations expressed in various terms including the following:

-- Mass of particulate matter per heat input into the process.

Example: 0.30 pounds per million British thermal unit.

-- Mass of particulate matter per unit of exhaust gas.

Examples: 0.05 grams per dry standard cubic foot.
0.01 grains per actual cubic foot.
0.02 grains per standard cubic foot.
0.04 pounds per ton of exhaust.
0.02 grains per actual cubic foot per minute.

-- Opacity of exhaust.

Example: 20 opacity.

-- Mass of particulate matter per time period.

Examples: 144.30 pounds per hour.
631.00 tons per year.
13.44 pounds per day.
4.5 grams per day.

-- Mass of particulate matter per area exposed to wind erosion.

Example: 5.80 pounds per acre.

-- Mass of particulate matter per mass of product input or output.

Examples: 0.02 pounds per ton coke.
0.30 pounds per ton kiln feed.
52.00 pounds per metric ton.

-- Mass of particulate matter per unit of power generated.

Example: 0.07 grains per horsepower hour.

-- Percent control of emissions.

Example: 98.00 percent control of particulate matter emitted due to overspray of coating material.

Regulations of these types for controlling all emitted particles have been the accepted practice for affecting ambient concentrations of particulate matter as measured by the high volume sampler even though emissions as measured by stack test methods may not be identical to the material measured by a high volume sampler. Despite this discrepancy, EPA has developed stack sampling trains now described in Methods 5 and 17 of Appendix B to 40 CFR Part 60 which represent the present state-of-the-art in techniques for collecting particulate matter. Many emission limits for particulate matter therefore have been established in terms of these measurement methods. In this document, the term "particulate matter emissions" is used to denote material measured by Methods 5 or 17 or by a comparable measurement method approved by EPA in a State implementation plan.

7.7 Surrogate Emission Regulations

This subsection discusses setting or retaining emission limits in terms of particulate matter emissions for the purpose of controlling PM_{10} emissions as part of a PM_{10} control strategy.

7.7.1 Retaining existing emission limits. If a State finds that its existing particulate matter emission limits in its TSP SIP are sufficient to prevent PM_{10} NAAQS violations, there is no need to go through a resource intensive process of modifying the emission limits to express them in terms of PM_{10}.* Modeling can be used in two ways to determine that a particulate matter emission limit or combination of limits for several sources is acceptable for PM_{10} control. First, particulate matter emissions can be modeled to determine the impact on ambient TSP levels. If the ambient TSP levels determined through modeling are below the concentration levels of the PM_{10} NAAQS, then the modeling results themselves indicate that PM_{10} NAAQS would not be violated. The particulate matter emission limits will then be acceptable for controlling PM_{10} emissions. Second, modeling can be done with particulate matter emission rates converted to PM_{10} emission rates. If it can be assumed that for any source the PM_{10} fraction of particulate matter does not vary appreciably during normal operation of the source, then a certain particulate matter emission rate will represent a certain emission rate of PM_{10} for that source. The PM_{10} fraction will, of course, vary by source and could be up to 100 percent of particulate matter emissions. For some sources the particulate matter emission rate in the TSP SIP can be converted to the corresponding emission rate for PM_{10} through an emission factor (see section 5.0 of this document). If a State uses this corresponding PM_{10} emission rate as input for modeling and finds that the modeling results indicate no violation of the PM_{10} NAAQS, then the particulate matter emission rate will be an acceptable emission limit for the PM_{10} SIP.

In either of the above cases, States may leave the existing emission limits unchanged and may continue to conduct compliance tests with appropriate particulate matter emission measurement methods. The PM_{10} control strategy analysis should include the modeling results and confirmation that the particulate matter emission limits were found to be acceptable surrogate emission limits for PM_{10}.

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*Regulations may consist of techniques such as paving a certain amount of dirt roads or streets, street sweeping schedules, tailings pile spraying, construction activity procedures, street salting restrictions, unpaved road speed limits, etc., rather than an emission limit.

7.7.2 Setting new emission limits. In the event that a State finds that an emission rate lower than the current particulate matter emission limit in the TSP SIP is necessary for PM_{10} NAAQS attainment and maintenance, the PM_{10} rate which is found to be necessary through modeling can be converted (through the use of an emission factor) to an equivalent particulate matter emission rate and expressed as such in the PM_{10} SIP. The emission limit expressed in terms of particulate matter emissions will be acceptable provided the modeling results are valid and the ratio of PM_{10} to particulate matter emissions is not likely to drastically change.

If it is found that substantially all of a source's emissions are PM_{10}, then limits for that source could be expressed as either particulate matter emission limits or PM_{10} emission limits, and compliance testing could be performed with either Method 5 or a method that measures only PM_{10} emissions. For such an instance, the SIP would have to indicate that the source's emissions are essentially all PM_{10}. In any case where an emission regulation is in terms other than PM_{10}, such as particulate matter emissions or opacity, PM_{10} levels must not increase while the indicator used in the emission limit remains constant. Otherwise, the indicator will not be a valid surrogate and emission limits using the surrogate will not be acceptable.

7.8 PM_{10}-Specific Emission Regulations

Emissions limits developed to meet the NAAQS for TSP took many forms as illustrated in section 7.6. Compliance with these limits was determined by reference method emission tests or certified visible emission observers. The emission limits and compliance methods had no direct link to TSP as measured by ambient monitors, however, a correlation was made through the use of dispersion and receptor models.

Similarly, it would be difficult, and perhaps technically infeasible, to develop a method for measuring precisely that exhausted material that would contribute to ambient levels of particulate matter measured by an ambient PM_{10} sampler. Particles emitted from stacks are subject to agglomeration and separation after they reach the ambient air, both of which affect their inclusion or exclusion in ambient PM_{10}. Additional complications arise due to the presence in emissions of condensables and various precursors of secondarily formed particulate matter. Regulations specifying emission limits as part of PM_{10} control strategies, therefore, cannot be directed toward exactly that exhausted material that contributes to ambient PM_{10}.

Rather, PM_{10} emission limits must be directed toward reducing the amount of PM_{10} emitted from a source as measured by an approved compliance test method. Suggested procedures for measuring PM_{10} emitted through stacks are discussed in Appendix C. Further guidance is being prepared by EPA.

7.9 Reporting Emissions Data

Emissions of pollutants for which NAAQS have been set are reported by States to EPA in an annual report required by 40 CFR 51.322. As a minimum, the sources for which emissions data are to be reported are those whose actual emissions are over 90.7 metric tons (100 tons) per year of the pollutant of concern. Since the indicator for both the primary and secondary standards for particulate matter is being changed from TSP to PM_{10}, reporting of particulate matter as required in section 51.322 will simply be replaced by reporting of PM_{10} emissions. The present requirement to report particulate matter emissions will end with the reporting of calendar year 1987 emissions. The reporting requirement for PM_{10} emissions will begin with the reporting of calendar year 1988 emissions. The EPA recognizes that time and resources are needed for States to develop the capability to report PM_{10} emissions data for EPA to develop the capability to process, store, and retrieve the data. States are required to begin the annual reporting of PM_{10} emissions data with calendar year 1988 data, which are to be sent to EPA Regional Offices by mid-1989. The EPA plans to provide States with the needed technical and procedural information in time for States to meet that requirement. This information includes PM_{10}-related changes to the following: AP-42, "NEDS Source Classification Codes and Emission Factor Listing;" the computer program for calculating emissions that is provided routinely to those States which use EPA's Emissions Inventory System (EIS); and provided to other States on request; and procedural information such as that contained in Aeros manuals.

The EPA has underway a project to replace the UNIVAC systems, e.g., NEDS, Hazardous and Trace Emissions System, that have been used for many years to process, store, and retrieve the emissions data provided by States. These systems will be replaced by IBM systems under EPA's Aerometric Inventory Retrieval System (AIRS) development program. The current schedule for having AIRS operational on the IBM system is March 1989. The EPA will provide the necessary guidance to the States in time for States to respond to the requirement for reporting calendar year 1988 PM_{10} emissions.

7.10 Emissions Trading (Bubble) Policy

This section clarifies the effect of PM_{10} NAAQS on alternative emission reduction options (bubbles) that have been previously approved for TSP SIP's. In the initial bubble policy, as published on December 11, 1979 (44 FR 71780), sources were warned that EPA was considering revising its particulate matter NAAQS and that if such size-specific standards were promulgated, some alternative approaches, initially approved by EPA, might no longer be adequate under the revised standards. In a sense, the policy indicated that sources which used a bubble approach to meet SIP emission limitations could be treated no differently from sources which did not. That is, if additional emission reductions are required to avoid violations of the ambient air quality standards, the State may have to revise emission limits previously approved under the bubble policy. In general, bubbles cannot interfere with a State's efforts to attain and maintain ambient air quality standards even if those standards are revised. The final Emission Trading Policy Statement promulgated December 4, 1986 (51 FR 43814) affirms this position.

7.11 Fugitive Dust Policy

The EPA will continue to implement its existing fugitive dust policy as it was applied in rural areas violating the TSP NAAQS. The EPA issued guidance on SIP development and new source review in areas impacted by fugitive dust on August 16, 1977.[7] This guidance, known as the Fugitive Dust Policy, states that "urban areas should receive the highest priority for development of comprehensive and reasonable programs to control fugitive dust." Control programs in rural areas are to "center on the control of large existing man-made fugitive dust sources (i.e., tailings, piles, mining operations, etc.) which in themselves are presently causing violations of the NAAQS or are sources of a known toxic or hazardous material (e.g., asbestos)."

Another aspect of the fugitive dust policy is that, "new sources that wish to construct in rural fugitive dust areas should be allowed to do so without the need of emission offsets, as long as they comply with the applicable emission regulation and the impact of their emissions plus the emissions from other stationary sources in the vicinity of the proposed location, along with normal background, is not projected to cause violations of the NAAQS." The following criteria were to be used in defining a rural area under the fugitive dust policy: "(1) the lack of major industrial development or absence of significant industrial particulate emissions and (2) low urbanized population (i.e. eastern states <100,000-200,000 or western states <25,000-50,000)."

In the initial process of categorizing areas into Groups I, II, and III, Group I and II areas that qualify as rural fugitive dust areas will be placed in Group III. The State will be expected to provide rationale and justification at the time of area categorization for the claim that a PM_{10} NAAQS may be violated primarily because of the impact of fugitive dust sources that are unreasonable to control.

In response to a broad range of comments on the proposal to continue this policy, EPA has developed several options for revising the fugitive dust policy for applciation to the PM_{10} NAAQS. Public comment on these options is currently being solicited. If necessary, a revised policy will be issued in the future. At that time, the categorization of areas initially placed in Group III under the existing policy will be reviewed for compliance with the revised policy.

References

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5. User's Guide: Fugitive Dust Control Demonstration Studies, EPA-600/8-84-032, U.S. Environmental Protection Agency, Research Triangle Park, NC, January 1985.

6. Field Evaluation of Wind Screens as a Fugitive Dust Control Measure for Material Storage Piles, EPA 600/7-86-027 U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. July 1986.

7. Memorandum from Edward F. Tuerk, Acting Assistant Administrator for Air and Waste Management to Regional Administrators, August 16, 1977.

APPENDIX A

TYPES OF RECEPTOR MODELS

There are several major categories of receptor models which are potentially valuable for better understanding an area's ambient particulate problem, both PM_{10} and TSP, and in formulating strategies for use in State implementation plans (SIP's). These include chemical mass balance (CMB) factor analysis (FA), optical microscopy (OM), and automated scanning electron microscopy (ASEM). While there are other techniques in addition to these, information and availability of the models or analytical methods are limited. The major receptor models are described briefly below and references are provided for more detailed information. [1,2,3,4,5,6,7,8]

1.0 Chemical Mass Balance

This method compares the chemical "fingerprints" or profiles of emissions from several source categories to the chemical composition of the sample. It is referred to in the literature by various names, including chemical mass balance, chemical element balance, species mass balance, and mass balance. Weighted least squares or some other statistical routine is used to find the relative proportions or mix of these sources which best "explains" or accounts for the composition of the sample. Species data (chemical compounds or elements) are required for both source and sample data. The method is most effective when the ambient samples are collected in at least two size fractions (larger than and smaller than 2-3 micrometers). This method must be validated in accordance with the protocol referenced at the end of this Appendix.[9]

2.0 Factor Analysis

Factor analysis and other multivariate statistical methods, such as multiple linear regression, target transformation factor analysis (TTFA), and cluster analysis, are all variations of the least squares routine used in mass balance. However, these methods (except TTFA) require no prior assumption of the impacting sources and can be useful where the types of sources are uncertain. Like the mass balance method, this method is most effective when used on size segregated samples. Factor analysis usually requires at least 40 observations to complete the analysis.

3.0 Optical Microscopy

Particle identification by optical microscopy is one of the first and most widely used methods of source apportionment of coarse particles. The technique relies on identification of particles by their size, shape, color, surface properties, and birefringence (i.e., an optical property). It is generally used on particles larger than 1 micrometer. Several analysts have been asked to provide quality assurance of their analyses and the results have been mixed. Optical microscopy appears to be somewhat analyst dependent and semiquantitative. However, it is an excellent confirmatory or supplementary techniques.

4.0 Automated Scanning Electron Microscopy

A computer-driven scanning electron microscope, equipped with x-ray fluorescence capability to identify the elemental composition, provides a particle-by-particle analysis of particle size, shape and elemental composition. This elemental composition and computer assisted sizing allows large numbers of particles to be analyzed and, thus, identified by source category in a relatively inexpensive manner.

5.0 Other Receptor Methods

The following methods are suggested to corroborate or refine MB, FA, OM, or ASEM analyses.

5.1 X-Ray Diffraction (XRD) - This method provides direct information on the crystalline nature of particles. This is particularly useful for distinguishing among minerals. It requires a heavy loading of coarse particulate matter on the filter and cannot be used on ammorphous (i.e., non-crystalline) particles.

5.2 Trajectory Analysis - This technique is used for tracing the history of an air mass to determine the possible area of origin of sources of ambient particulate. The simplest form is the pollution rose, where only average wind direction is considered. More sophisticated approaches account for the changing wind direction with time to trace air mass in time and space for as long as several days.

5.3 Microinventory - This technique is an orderly compilation of sources near a receptor. This is particularly useful as a finely gridded input to dispersion models, and in qualitatively estimating the potential sources of soil and other minerals to help interpret an observed mix of particulate matter on an ambient filter.

References

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2. Receptor Model Technical Series, Volume II: Chemical Mass Balance. EPA-450/81-016b, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1981.

3. Receptor Model Technical Series, Volume III: User's Manual For Species Mass Balance Computer Program. EPA 450/4-83-014. U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1983.

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5. Digest of Ambient Particulate Analysis and Assessment Methods, EPA-450/ 3-78-113, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1978.

6. G. E. Gordon, Receptor Models, Environmental Science and Technology, 1980, 14, 792-800.

7. Receptor Model Technical Series, Volume V: Source Apportionment Techniques And Considerations In Combining Their Use, EPA 450/4-84-020. U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1984.

8. Receptor Model Technical Series, Volume VI: A Guide To The Use of Factor Analysis And Multiple Regression (FA/MR) Techniques in Source Apportionment, EPA 450/4-85-007. U.S. Environmental Protection Agency. Research Triangle Park, NC, July 1985.

9. Pace, T. G., et al., Protocol For Applying And Validating The CMB. U.S. Environmental Protection Agency, Research Triangle Park, NC, 1986 Draft.

APPENDIX B

PRELIMINARY ESTIMATES OF PM_{10} DESIGN CONCENTRATIONS USING TSP DATA

This appendix provides a methodology for making a preliminary estimate of particulate matter (PM_{10}) design concentrations where actual PM_{10} measurements are not available. These estimates may be derived based on relationships between PM_{10} and TSP, as described in the probability guideline. The definitions of design concentrations used in this appendix are consistent with those presented in Section 6.0. Preliminary design concentrations developed by this Appendix method shall not be used for developing control strategies. They may be used for preliminary planning and to help evaluate design concentrations estimated by dispersion models. Procedures for making preliminary estimates of annual design concentrations and 24-hour design concentrations are included.

1.0 Annual NAAQS

1.1 Recommendations

(1) Use the most recent years for which a valid annual arithmetic mean* exists to determine annual arithmetic mean TSP concentration, and

(2) Multiply the annual arithmetic mean TSP concentration determined in (1) times a factor of 0.47.**

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*A valid arithmetic mean requires at least 12 observations per quarter. In the simplest case, to compute the design concentration one should use the average mean from the 3 most recent years of data. However, if only 1-2 years of valid means are available, these may also be used.

**The 0.47 factor is the 50th percentile ratio in Table 2 of Procedures For Estimating Probability Of Nonattainment Of A PM_{10} NAAQS Using Total Suspended Particulate Or Inhalable Particulate Data.

(3) The resulting product of (1) and (2) is the "design concentration" for the annual arithmetic mean PM_{10} value.

1.2 Example

(1) Given: Valid average annual arithmetic mean TSP = 140 μ/m^3
PM_{10} NAAQS = 50 μ/m^3 annual arithmetic mean.
Sampling is performed according to a systematic sampling schedule.

(2) Solution:

$$d = (0.47)\ (140)$$

$$d = \underline{66\ \mu g/m^3}$$

2.0 24-hour NAAQS

2.1 Background

Unlike the annual design concentration, a design concentration for implementing the 24-hour NAAQS requires some explanation before recommendations concerning the derivation can be given. The 24-hour NAAQS is met when the expected exceedance rate (EER) is less than or equal to 1.0 per year. When TSP measurements are the only measurements of particulate matter available, the calculated EER is a function of:

(1) the relationships between PM_{10} and TSP as described in the probability guideline,

(2) the observed distribution of TSP values, and

(3) the number of samples.

In deriving the design concentration, one should remember that the design concentration, d, is that value of PM_{10} which, when reduced to the level of the NAAQS, ℓ, would result in an expected exceedance rate (EER) of 1.0 per year. Hence,

$$\ell = (m)(d) \tag{1}$$

where $m = (1-[\text{required reduction in d}])$

Two assumptions are implicit in the definitions above:

(1) all TSP_i values in the existing distribution of TSP concentrations are reduced by (1-m), and

(2) all corresponding $(PM_{10})_i$ values are also reduced by (1-m).

The expected exceedance rate (EER) is calculated using equation (2).

$$EER = \frac{N}{S} \sum_{i=1}^{n} P(R_i > \frac{\ell}{(TSP)_i}) \qquad (2)$$

where

N = number of days per year (e.g., 365)
S = number of TSP samples
n = number of TSP samples with values greater than ℓ, the level of the NAAQS
R_i = ratio of $(PM_{10})_i/(TSP)_i$
= level of the NAAQS (e.g., 150 μg/m^3

and

$P(R_i > \frac{\ell}{(TSP)_i})$ = the probability that a given $(TSP)_i$ value corresponds to a $(PM_{10})_i$ concentration which is greater than the level of the NAAQS.

Noting that the design concentration is defined as that value which must be reduced to the level of the NAAQS such that EER = 1.0, and that for this to occur each $(TSP)_i$ value must be reduced to m $(TSP)_i$, equation (2) becomes

$$1.0 = \frac{365}{S} \sum_{i=1}^{n} P(R_i > \frac{\ell}{m\,(TSP)_i}) \qquad (3)$$

One further substitution can be made by substituting the relationship in equation (1) into equation (3).

$$1.0 = \frac{365}{S} \sum_{i=1}^{n} P(R_i > \frac{d}{(TSP)_i}) \qquad (4)$$

This allows the design concentration "d" to be expressed explicitly in equation (4).

To calculate the average exceedance rate over a period of k years, equation (4) should be applied separately for each year to estimate each annual expected exceedance rate $(EER)_j$. The $(EER)_j$ are then averaged as shown in equation (5).

$$1.0 = \frac{365}{k}\left[\sum_{j=1}^{k} \frac{1}{S_j}\left[\sum_{i=1}^{n} P(R_{ij} > \frac{d}{(TSP)_{ij}})\right]\right] \quad (5)$$

where

k = number of years considered
S_j = number of observations during year j

Equation (5) is solved iteratively for "d" until the right hand side (rhs) of the equation becomes equal to 1.0.

2.2 Recommendations

Because the recommended procedure for estimating the 24-hour design concentration for PM_{10} from TSP data is an iterative one, it is recommended that the estimate be made using a computer. Software for doing this is available and is described in User's Guide for PM_{10} Probability Guideline Software.* For those wishing to perform the calculations by hand, a suitable procedure is described below.

(1) Assume an initial value of "d" twice as high as the level of the PM_{10} NAAQS (i.e., 300 $\mu g/m^3$ for a NAAQS having a level of 150 $\mu g/m^3$);

(2) Using Figure B.1,** for each $(TSP)_{ij}$ value greater than the level of "d," calculate the probability that the corresponding $(PM_{10})_{ij}$ value would be greater than this level, i.e.,

$$P(R_{ij} > \frac{d}{(TSP)_{ij}})$$

Note that

(a) if $\frac{d}{(TSP)_{ij}} < 0.14$, assume $P(R_{ij} > \frac{d}{(TSP)_{ij}}) = 0.99$

(b) if $\frac{d}{(TSP)_{ij}} > 0.95$ but ≤ 1.00, assume $P(R_{ij} > \frac{d}{(TSP)_{ij}}) = 0.01$

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*W. P. Freas, User's Guide for PM_{10} Probability Guideline Software, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Monitoring and Data Analysis Division, Research Triangle Park, North Carolina 27711. In Preparation.

**Figure B.1 has been reproduced from Table 2 of the probability guideline.

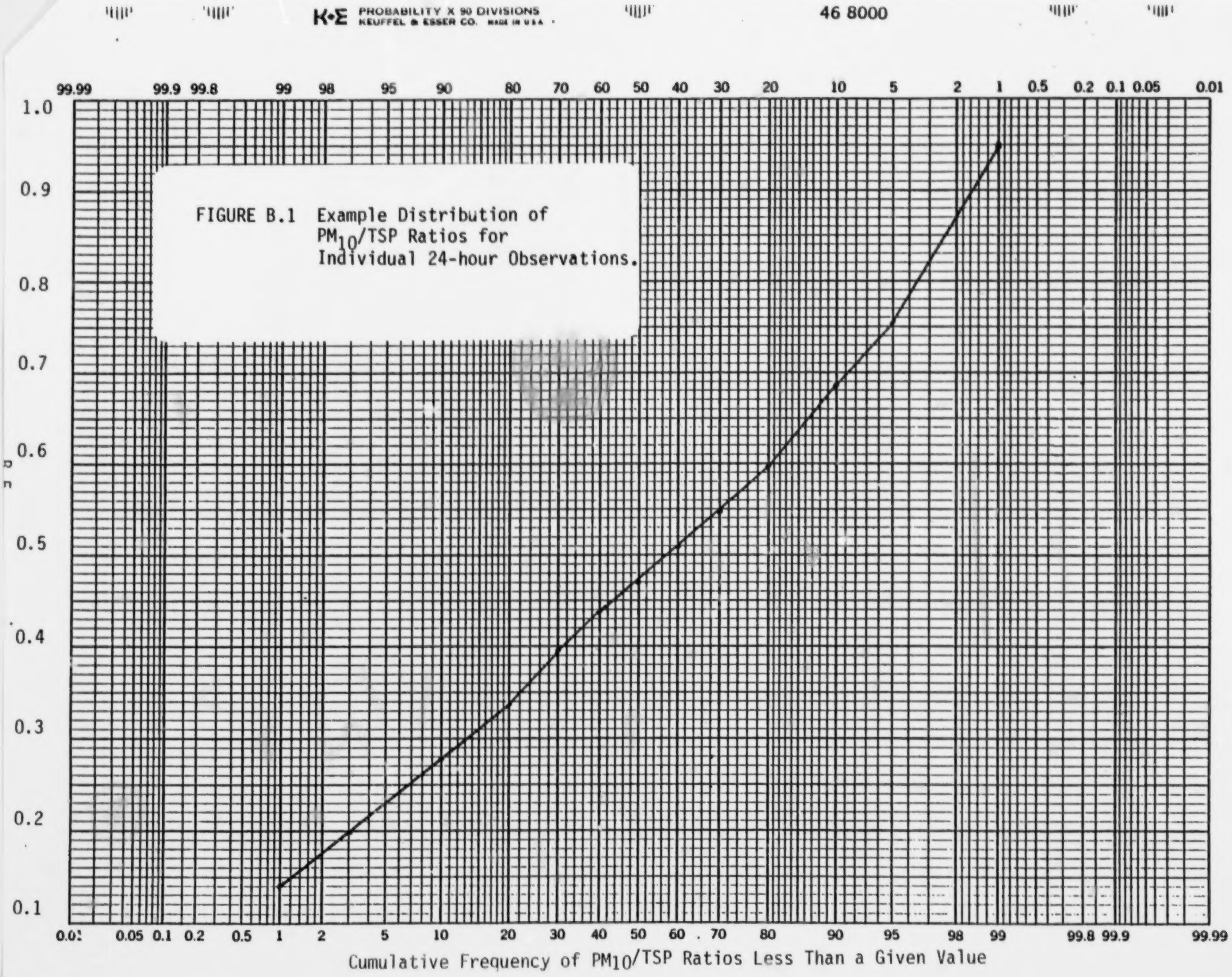


FIGURE B.1 Example Distribution of PM_{10}/TSP Ratios for Individual 24-hour Observations.

or

(c) if $\left(\frac{d}{TSP}\right)_{ij} \geq 1.00$, assume $P\left(R_{ij} > \left(\frac{d}{TSP}\right)_{ij}\right) = 0$

(3) Use the information in step (2) to determine the value of the rhs of equation (5).

(4) (a) if $0.99 \leq \text{rhs} \leq 1.01$, then the design concentration is equal to the value of "d,"

(b) if rhs > 1.01, increase the value of "d" and repeat steps (2) and (3);

(c) if rhs < 0.99, decrease the value of "d" and repeat steps (2) and (3).

(5) If there are fewer than 48 samples in any year, disregard the data from that year in performing the preceding calculations.

2.3 Example

Given: (1) Three years of TSP sampling data in which 61 days per year are sampled,

(2) Five days in which $(TSP)_i$ was observed to be greater than 150 $\mu g/m^3$. These values are 500 and 240 $\mu g/m^3$ in year 1, 400 and 350 $\mu g/m^3$ in year 2, and 300 $\mu g/m^3$ in year 3.

Find: The design concentration of the 24-hour NAAQS for PM_{10}.

Solution: (1) Assume d = 300 $\mu g/m^3$, compute each $P\left(R_{ij} > \frac{d}{TSP}\right)_{ij}$ and tabulate the information as shown below

j	i	$(TSP)_i$	$300/(TSP)_i$	$P(R > 300/(TSP)_i)$
1	1	500	0.60	0.20
1	2	240	> 1.00	0
2	3	400	0.75	0.05
2	4	300	1.00	0.
3	5	350	0.86	0.02

(2) Use the information in the last column in the preceding table to test equation (5)

$$1.00 \overset{?}{=} {}^{365}/_{3} \left[\frac{1}{61}[0.20 + 0] + \frac{1}{61}[0.05 + 0] + \frac{1}{61}[0.02]\right] \quad (5)$$

$$1.00 \neq 0.54$$

(3) Since 0.54 < 0.99, we need to lower the trial design concentration, d. For a second trial value of "d," halve the difference between the level of the NAAQS and trial 1. Therefore, the value for "d" in trial 2 is 225 μg/m^3.

j	i	$(TSP)_i$	$225/(TSP)_i$	$P(R > 225/(TSP)_i)$
1	1	500	0.45	0.56
1	2	240	0.94	0.01
2	3	400	0.56	0.26
2	4	300	0.75	0.05
3	5	350	0.64	0.14

and

$$1.00 = {}^{365}/_{3}\left[\frac{1}{61}[.56 + .01] + \frac{1}{61}[.26 + .05] + \frac{1}{61}[.14]\right]$$

$$1.00 \neq 2.03$$

Since 2.03 > 1.01, we need to raise the design concentration "d" for trial 3. This is done by taking half the difference between trials 1 and 2 and adding it to the design concentration in trial 2. Hence, the design concentration for trial 3 becomes $225 + \frac{(300-225)}{2} = 263$ μg/m^3

j	i	$(TSP)_i$	$263/(TSP)_i$	$P(R > 263/(TSP)_i$
1	1	500	0.53	0.34
1	2	240	> 1.00	0
2	3	400	0.66	0.12
2	4	300	0.88	0.02
3	5	350	0.75	0.05

$$1.00 \stackrel{?}{=} \frac{365}{3}\left[\frac{1}{61}(0.32 + 0)) + \frac{1}{61}(0.07 + 0.01) + \frac{1}{61}(0.02)\right]$$

$$1.00 \neq 1.06$$

Since 1.06 > 1.01, we must raise the design concentration for trial 4 by adding one-half the difference between the design concentrations used in trials 2 and 3 to the design concentration in trial 3. Hence, the design concentration for trial 4 becomes $263 + 1/2\ (^{263-225}) = 282$ μg/m^3.

This binary search procedure is continued to derive subsequent trial values for "d" until finally we reach a trial value of 268 μg/m^3.

j	i	$(TSP)_i$	$268/(TSP)_i$	$P(R > 268/(TSP)_i$
1	1	500	0.54	0.32
1	2	240	> 1.00	0
2	3	400	0.67	0.11
2	4	300	0.89	0.02
3	5	350	0.77	0.05

$$1.00 \stackrel{?}{=} \frac{365}{3} \left[\frac{1}{61} (0.32 + 0) + \frac{1}{61} (0.11 + 0.02) + \frac{1}{61} (0.05)\right]$$

$$1.00 = 1.00$$

Therefore, use d = 268 $\mu g/m^3$ as the design concentration for PM_{10} at this monitoring site. Note that if the sample size in year 2 had been less than 48, we would ignore the data from year 2, and equation (5) would have been applied as shown below,

$$1.00 = {}^{365}/_{2} \left[\frac{1}{S_1} \sum_{i=1}^{n} P(R_{ij} > \frac{d}{(TSP)_{i1}}) + \frac{1}{S_3} \sum_{i=1}^{n} P(R_{ij} > \frac{d}{(TSP)_{i3}}) \right]$$

APPENDIX C

GUIDELINES FOR SOURCE TESTING FOR SIZE SPECIFIC PARTICULATE EMISSIONS

1.0 Introduction

The introduction of a size-specific, ambient particulate standard may necessitate source measurements on a similiar basis. The EPA is providing this guideline not as a mandated requirement, but as guidance for those States that want to develop emission factors beyond those which we will provide in Section 5. This guidance may also be useful to States which want to develop compliance methods for future PM_{10} SIP emissions limits. The material presented here is intended for the use of knowledgeable stack testers in modifying existing techniques for gathering PM_{10} data. The EPA is currently developing PM_{10} measurement methods and will provide more detailed guidance following promulgation.

The net contribution of a source to PM_{10} in the ambient air arises from both primary and secondary emissions. Secondary emissions are defined here as those which result from chemical or physical reactions in the ambient air. Primary particulate emissions are defined here to include particles which were present in the process gas stream prior to discharge to the atmosphere as well as modifications to those particles and new particles formed by condensation phenomena as the process gases are cooled upon discharge. Testing methods which include the contributions from "condensation" are currently under development but are not yet generally available (Smith et al, 1982). The data currently available indicate that the "condensibles" from many sources with good particulate controls may constitute a major fraction of their present contributions to ambient air particulate concentrations (Williamson et al., 1982). The EPA Method 5 (40 CFR

60), with a filter temperature of 120°C, includes some condensibles in the material collected (EPA 450/3-81-005a). However, further temperature reduction in many cases results in substantial increases in measured emission rates (Williamson et al.: op cit). The methods to be described below focus primarily on the measurement of size fractionated particulate matter as it exists at stack conditions. However, the inclusion of those portions of the condensibles that are currently collected as part of the EPA Method 5 catch can be readily achieved by the removal of the final filter from the instack samplers described below and instead using a Method 5 filtration system. The problem of complete measurements of primary emissions including proper handling of condensibles measurement will be addressed at a future date.

2.0 Available Methods for Size Specific Source Measurements

Because the PM_{10} standard is one based on the aerodynamic behavior of particles, inertial classification is the appropriate technique to use. The likelihood of irreversible agglomeration or coalescence occuring upon contact of particles with one another precludes the use of laboratory particle sizing methods for the determination of PM_{10} emissions from industrial sources. Rather, particle classification on an aerodynamic size basis must be accomplished while the sample is being taken. This can be done using either of two types of inertial classifiers--cascade impactors or cyclones. If PM_{10} emissions only (not detailed size distributions) are to be measured, a single stage classifier would be the most desirable device to use.

Size fractionating source samplers have been produced with as few as one and as many as 25 stages with each stage of the multistage devices having a different cutoff diameter. The samplers having the greater number of stages provide more detailed information on the aerosol size distribution, and generally have higher capital and operating costs. Impaction type size classifiers are much more prone to errors due to overload and particle bounce than are cyclones; consequently, multistage operation is virtually mandatory with them in order to insure data reliability (Harris, 1977). A sound theoretical basis exists for predicting the performance of cascade impactors (Marple, 1970). Cyclone samplers perform well as single stage collectors; however, no adequate theory exists at present to predict their behavior over a wide range of operating conditions. This limits the use of cyclones to those which have been demonstrated to produce the necessary particle size cutoff by empirical calibration procedures (Smith et al, 1982). Cyclones with acceptable sharpness of cut have been developed and are available from commerical vendors. Evaluation of these devices have demonstrated nominal 10 um cuts over a limited range of operating conditions, and further characterization of the devices is in progress. Cyclone samplers are preferred for sampling to quantify size specific mass emissions; however, the protocol described here is generally applicable to both impactor and cyclone sampling with details that are pertinent to only one of the methods noted as they arise.

3.0 Selection of Sampling Traverse Points

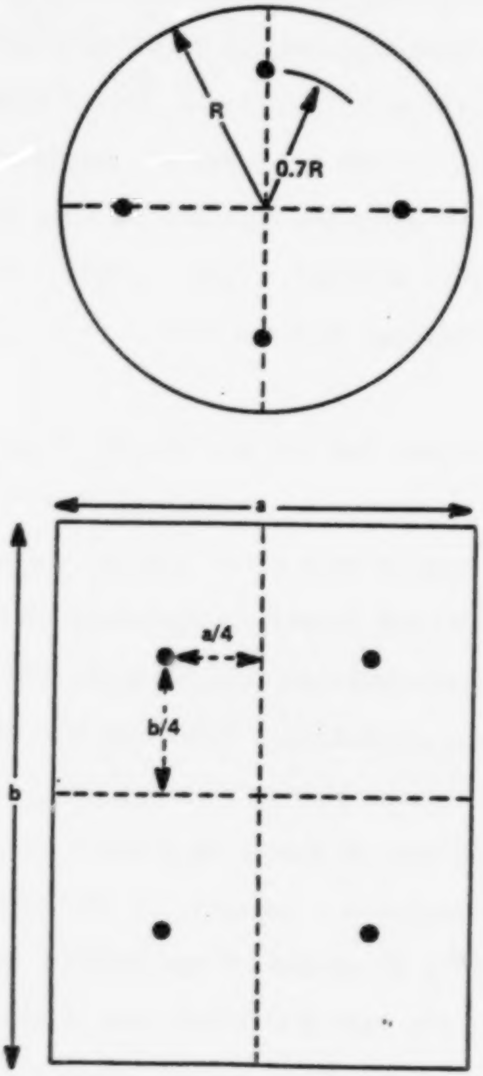
In order to obtain a representative measurement, one must obtain samples at representative points across the duct (stack) at isokinetic rates. In the case of conventional particulate testing (e.g. EPA Methods 5 and 17), this is accomplished by dividing the duct into a large number of equal area segments and traversing this sampling plane to obtaining an isokinetic sample at the center of each of these areas. Isokinetic sampling is achieved by selecting a nozzle which is appropriate for the combination of the nominal flow rate at which the sampler is intended to operate and the average duct gas velocity. Compensation for variations in the duct gas velocity is then achieved by modulating the sampling rate. This procedure cannot be used with inertial particle size classifiers because changes in the sampling rate also changes the diameter(s) at which size fractionation takes place. However, to require fixed sampling rates adds immensely to the complexity of the testing and subsequent data reduction and interpretation.

A method is currently being investigated which permits complete traverses of the sampling plane using variable sampling rates to be made with cyclones and impactors in a fashion similar to EPA Method 5. It is called the emission gas recycle (EGR) approach. The method uses a recirculation loop to augment the sample flow through the sizing device. This permits the operator to maintain a fixed flow through the sampler while varying the sampling rate from the duct by means of compensating changes in the recirculation flow. Upon satisfactory development of the EGR method, the protocol for traversing the sampling plane for size specific sampling will be virtually identical to that of Method 5.

An alternative procedure for obtaining a representative multipoint traverse in a single run with a fixed flow rate sampler involves changing the sampling nozzle as necessary at each sampling point to match the sampling velocity to the duct velocity within an allowable 20 percent tolerance. The volume of gas sampled at each point is then made proportional to the volumetric flow through the area represented by the sample point by making the sampling duration at each point proportional to the gas velocity at the point. This technique will work with any velocity distribution but may be cumbersome to implement.

Another method of obtaining an isokinetic sample using a fixed flow rate sampler is to synthesize a complete sample from a multiplicity of single point samples. Obviously the time and expense involved in such an approach would be excessive if the number of samples taken equaled the number of traverse points normally required in Method 5 compliance testing. However, a method which utilizes this approach, called simulated Method 5 (SIM-5) is being developed. In the SIM-5 method, one sample is obtained from all traverse points for which the duct gas velocity falls within a specified range (usually ± 20 percent). Then a complete sample can be composed from the partial samples obtained from traverse points with similar gas velocities.

In the interim, while awaiting the development of the SIM-5 method, a simple four point sampling grid may be used (Smith et al., 1982). With a particle size sampler located at each grid location, one sample at each location is needed to obtain one complete measurement of the net source emission rate (the net source emission rate being the sum of the emission rates from each of the four quadrants). Three complete measurements should be made to characterize the source emission rate; thus, a total of 12 particle size samples (3 samples at each of 4 grid locations) will usually be required to obtain one complete measurement. However, if the velocities at the four sampling points are within ± 20 percent of one another, one sampler operating for equal time at each of the four grid points can obtain one sample. This will reduce the number of samples required from 12 to 3. The locations of the four sampling points are shown in Figure C-1.


R
0.7R
a
a/4
b/4
b

4181-2B

FIGURE C-1. RECOMMENDED SAMPLING POINTS FOR CIRCULAR AND SQUARE OR RECTANGULAR DUCTS.

Implementation of all of the traverse methods described above require obtaining velocity traverses and gas composition using EPA Methods 1, 2, 3, and 4 followed by precalculation of sampling flow rate, nozzle selection, etc. before sampling commences. The total gas flow to be used in calculating emission rates using any of the reduced point traverses must be obtained using EPA Method 2.

4.0 Sampler Selection and Operation

Cyclone samplers for PM_{10} measurements are available on the commercial market. Any of a number of cascade impactors are available, also. High flow rate (10 to 30 alpm) samplers are desirable for sampling low concentration streams such as are anticipated herein. If a high concentration (>500 mg/m^3) stream is to be sampled an impactor with a design flow rate of about 3 lpm would be more useful. The need to use different samplers for different particle concentrations arises from a fundamental operating limit of impactors. Under most circumstances, no more than about 10 mg can be collected on any one impactor stage; beyond this limit particle reentrainment can invalidate the data. As a rule this means that only about 50 mg can be collected in total throughout the impactor. High flow rate impactors reach this load limit too rapidly for practical use in high concentration situations (Harris, 1977). Cyclone samplers have sufficient capacity that a single high flow rate device will suffice for all applications.

Sampling nozzle selection is more complex when sampling to obtain particle size related information than when sampling for total particulate loading. Two major factors are added regarding nozzle selection.

Because of size selective deposition in bends, the sampling nozzles must be straight for use in particle sizing (Knapp, 1979; Felix and McCain, 1981). Thus one cannot use "gooseneck" or other nozzles designed to turn the sampled gas flow 90 degrees (as is done in Method 5). The natural right angle orientation of the inlet of a cyclone sampler with respect to the sampler body and exit makes the use of straight nozzles normal with them. This is not the case with impactors. One approach to the use of straight nozzles with impactors is to align the impactor axis with the direction of gas flow in the duct. However, in many sampling locations this is impractical if not virtually impossible. The use of a high capacity precollector having an inlet at 90 degrees to the body eliminates this difficulty and, at the same time, eliminates another operational problem with impactors. If a significant proportion of the particles being sampled are larger than about 10 to 15 um, the first collection stage tends to reach its loading limit before the succeeding stages collect enough material for reliable weighing. The use of a high capacity precollector which has a cut larger than that of the first impactor stage helps alleviate the overload problem. Several such precollectors, some of cyclonic design and others operating on impaction principles, are comercially available. Of the impaction type precollectors, only those which have inlets and exits at 90 degrees to one another are acceptable for this application.

The particle size of the samplers, both cyclones and impactors, are dependent on a number of factors with the sampling flow rate being the only variable which can be adjusted by the user. However, the sample flow rate required to obtain the PM_{10} cut will be dictated by the sampler used (given the gas composition and temperature of the process stream being measured). This means that one does not have the latitude in selecting the sampler flow to be used that one has in simple total particulate measurements. The matching of the sample inlet velocity with the gas stream velocity for isokinetic sampling must be accomplished entirely through the cross-sectional area of the sampling nozzle. This means that a much larger array of nozzles must be available than those used in Method 5 sampling. If the isokinetic error is no larger than 20 percent, the maximum error in the measured emission rate of 10 um particles will be about 15 percent and the errors for smaller particles will be lower. Thus, the actual error in the total concentration of particles smaller than 10 um will be substantially lower than 15 percent. Thus deviations of ± 20 percent from isokentic can probably be tolerated. If sampling is to be done within ± 20 percent of isokinetic, an array of nozzles must be available that step by 20 percent in diameter from one to the next.

If a single stage collector is used, the geometry of the collector and the flue gas conditions will completely dictate the sampling flow rate as only one flow rate will produce the required size cut. If a multistage device is used to measure the complete size distribution, some latitude is available in setting the flow because interpolation can be used to determine the concentration of particles in the designated size range.

5.0 Sampling Trains

The sampling train requirements for the particle size specific method(s) are similar to those of Methods 5 and 17 and trains designed for the latter applications can be used with some impactors and cyclones. However, Method 5 systems are not adaptable to the intermediate and low flow rate (<20 alpm) devices without modification. The orifice meters used in the Method 5/17 systems are too large to permit accurate flow measurement and control at these reduced flow rates. A substitute orifice meter, properly sized for the specific sampler, can be used in place of the standard orifice to make a Method 5/17 system compatible with the sampler. Alternative trains and probes are described by Harris (Harris, 1977). As the sampling procedure described here is intended to measure only particulate material as it exists at stack conditions, the sampler must be operated instack. That is, the size fractionating device and backup filter must be mounted on the outboard end of the probe (replacing the usual sampling nozzle). A typical setup is illustrated in Figure C-2. The particle size fractionating portion of the system cannot be located at the exhaust end of the probe because of size selective particle losses resulting from deposition in the probe. A Method 5 filter system may be used at the exhaust end of the probe, with the instack filter removed as illustrated in Figure C-3, to obtain an estimate of the condensible emissions and to provide a method for determining the fraction of Method 5 concentrations that fall within the defined particle size range.

Detailed procedures for the use of cascade impactors for industrial source sampling are described by Harris (Harris, 1977). Procedures for the use of cyclone samplers are described by Smith et al., (Smith et al, 1982). Some of the procedures described in the latter document are specific to a set of cyclones designed to provide a 15 um size cut, but with the exception of the actual flow rates to be used, the same protocol is to be followed for the sampling described here.

6.0 Collection Media

In sampling operations in which the particles are not further size fractionated beyond the PM_{10} cyclone, the filter specifications are the same

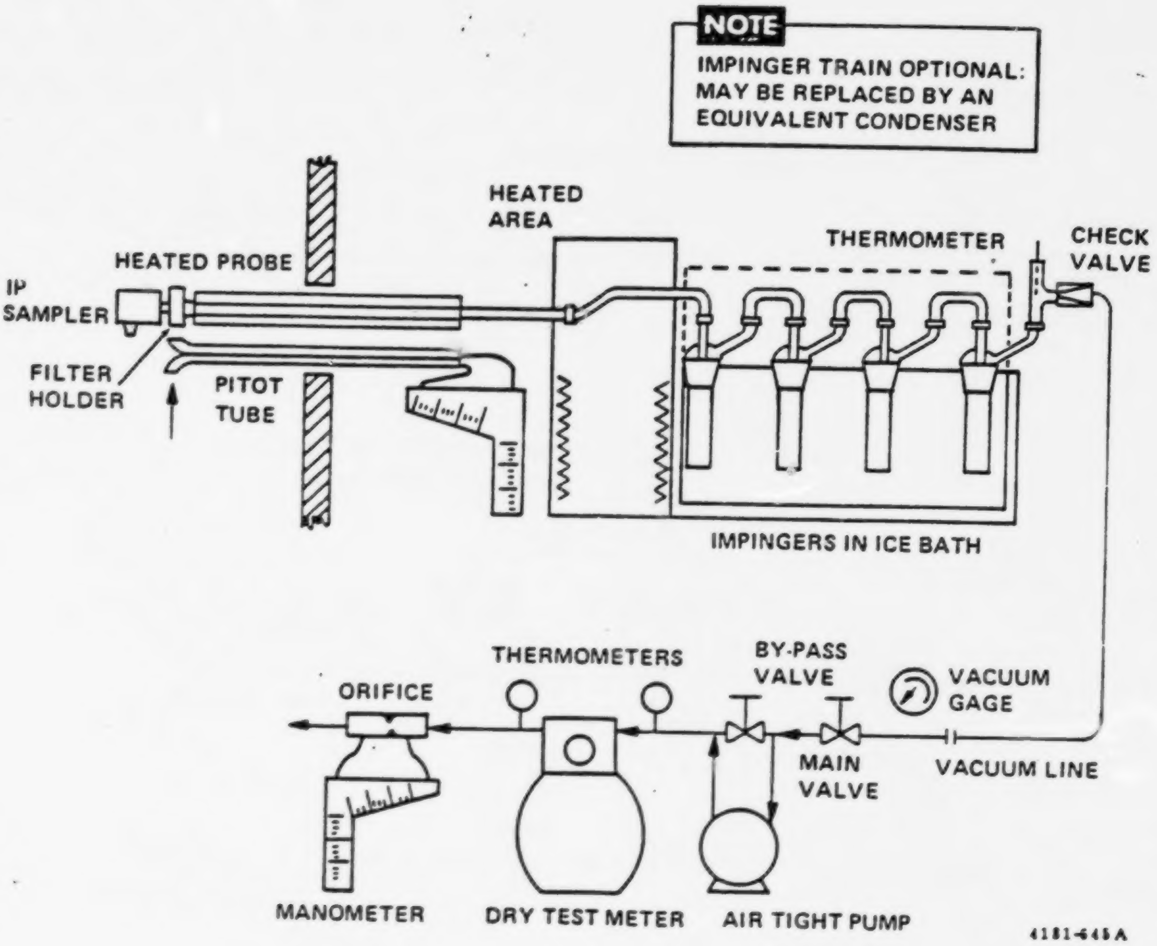

NOTE
IMPINGER TRAIN OPTIONAL: MAY BE REPLACED BY AN EQUIVALENT CONDENSER
HEATED AREA
HEATED PROBE
THERMOMETER
CHECK VALVE
IP SAMPLER
FILTER HOLDER
PITOT TUBE
IMPINGERS IN ICE BATH
THERMOMETERS
BY-PASS VALVE
VACUUM GAGE
ORIFICE
MAIN VALVE
VACUUM LINE
MANOMETER
DRY TEST METER
AIR TIGHT PUMP
4181-645A

FIGURE C-2. PM10 PARTICULATE SAMPLING TRAIN FOR NONCONDENSIBLE PARTICULATE (MODIFIED EPA METHOD 5 TRAIN)

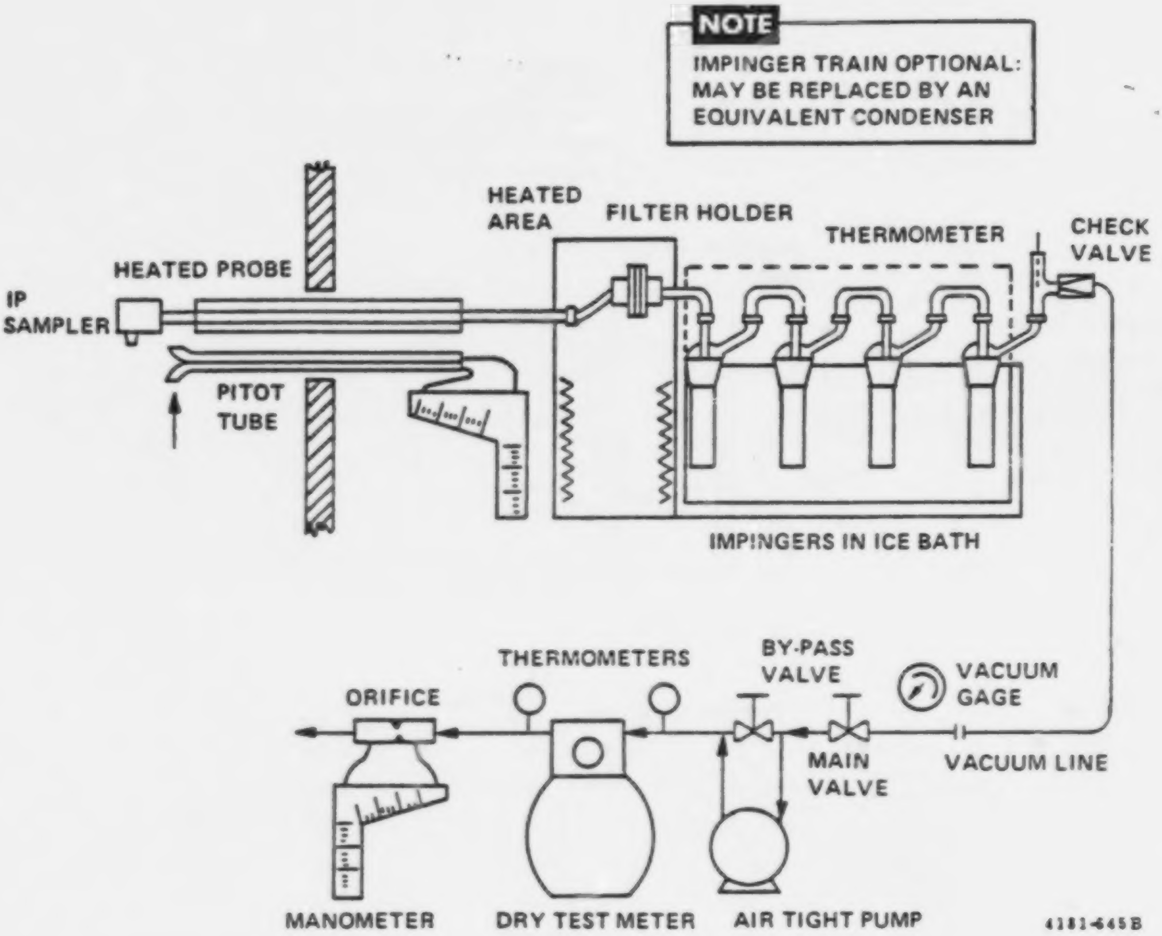

NOTE
IMPINGER TRAIN OPTIONAL:
MAY BE REPLACED BY AN
EQUIVALENT CONDENSER
HEATED AREA
FILTER HOLDER
THERMOMETER
CHECK VALVE
HEATED PROBE
IP SAMPLER
PITOT TUBE
IMPINGERS IN ICE BATH
THERMOMETERS
BY-PASS VALVE
VACUUM GAGE
ORIFICE
MAIN VALVE
VACUUM LINE
MANOMETER
DRY TEST METER
AIR TIGHT PUMP
4181-645B

FIGURE C-3. PM10 PARTICULATE SAMPLING TRAIN FOR CONDENSIBLE AND NONCONDENSIBLE PARTICULATE (MODIFIED EPA METHOD 5 TRAIN).

as those for EPA Methods 5 and 17. However, if a cascade impactor is used, extra requirements are imposed. A surface coating is required on the collection plates of the impactor in order to insure adequate retention of impacted particles. This coating can be in the form of a glass fiber mat or a grease or polymeric coating on a lightweight metal foil (Harris, 1977). Chemical reactions involving gas phase constituents of the process stream, especially SO_2, can occur with these coatings and significantly alter the apparent weight collected by each stage (Smith et al., 1975). All glass fiber materials used in impactor sampling must be treated to minimize SO_2 uptake. The procedure for the treatment is given by Cushing and Smith (Cushing and Smith, 1979). Because the interferences are not predictable, control runs must be made together with the actual sample runs as the testing takes place (Harris, 1977).

All collection media must be dessicated prior to the initial weighing and dessicated for a minimum of 12 hours prior to the final weighing after sampling.

7.0 Data Reduction and Analysis

Ultimately, the information to be determined from a set of measurements is the particulate emission rate in the PM_{10} size fraction together with a measure of the uncertainty in the calculated rate. If the traverse of the stack required multiple single point samples, emission rates must be separately calculated for each point and summed to obtain the total rate. Emission rates should be calculated for each of the three traverses of the duct and averaged. The average represents the final value to be reported. Isokinetic errors would be calculated for each sample in the manner prescribed by EPA

Method 5. The average isokinetic error for each traverse must be less than ± 20 percent for the individual traverse to be accepted. The relaxation from the ± 10 percent requirements of Method 5 is possible because the errors associated with an isokinetic sampling of small particles are not as great as those for larger particles, and Method 5 must be able to deal with all sizes.

If the sampler(s) are operated so as to provide a size fractionation point at the required 10 um diameter, the particle concentration to be used in the emission rate calculation is that based on the quantity of material which passed the appropriate stage of the sampler. If a single stage sampler is used, the actual size fractionation diameter for each sample must be calculated based on the calibration of the sampler, the gas volume sampled, and the composition and physical conditions of the flue gas. For a sample to be accepted, the size fractionation diameter calculated for the sampler from actual run conditions must be within ± 10 percent of the required diameter. If the complete size distribution is measured, the particle concentration to be used in calculating the emission rate can be found by interpolation (or, within limits, extrapolation) of the cumulative concentration versus particle size curve generated from the data for each run. Methods for accomplishing this are described by Smith (Smith et al., 1982). Cascade impactor data can be reduced on a single run basis using a sophisticated data reduction program, PADRE, which was developed under EPA sponsorship. This program can be accessed through a local phone link in most U.S. cities and there are no charges for the use of the service. Details on the data reducion system can be found in "PADRE User's Guide" (EPA-600/58-84-012).

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APPENDIX D

DETERMINATION OF PM_{10} BACKGROUND

1.0 Introduction

Development of State implementation plans (SIPs) for PM_{10} will require an estimate of PM_{10} background concentrations for use with either dispersion or receptor model based control strategy development. The term "background" has a number of different interpretations. For the purpose of SIP development, background is defined as that portion of (ambient) concentrations due to natural sources, nearby sources other than the one(s) currently under consideration, and unidentified sources. General guidance on background concentrations for all pollutants is provided in Guidelines on Air Quality Models.[1] The purpose of this Appendix is to outline in greater detail the considerations and procedures which should be used to determine background concentrations of PM_{10}. As will be seen, selection of an appropriate background concentration depends on the time period of concern (e.g., annual or 24-hour), meteorological conditions of interest and the availability of data.

In a dispersion modeling study, background should account for the impact of source emissions not considered in the model. Such emissions may be either of manmade or natural origin and may be either primary (directly emitted as particles or condensable vapors) or secondary (emitted as gases and transformed into particles during transport). Ideally, all sources should be modeled, but this is not always possible or practical for particulate matter. In some cases, the sources may be within the agency's jurisdiction, but their emissions are not included explicitly in the model (perhaps because they are too small or too numerous to inventory). In other cases, the sources may be outside the region of jurisdiction and not identifiable. However, all sources must be accounted for either explicitly by the model or in the background value.

Receptor modeling studies may also be used to develop control strategy emission limits, as outlined in Section 6.0 of this document. Since a receptor analysis may apportion the entire sample (including background), the analysis may reflect contributions from some sources which are or should be ascribed to background. Section 3.0 of this Appendix discusses this in more detail.

For dispersion model studies, the background concentration is usually needed for the set of meteorological conditions and time periods (e.g., annual, seasonal or 24-hour) associated with the exceedances of the NAAQS. Receptor models usually require the estimate for the specific time period represented by the receptor analysis. However, receptor model studies may also be developed that represent a particular set of meteorological conditions. This need for background to represent a particular set of meteorological conditions is discussed in Sections 3.0 and 4.0 of this Appendix.

2.0 Determining Background Estimates From Measured PM_{10} Or Surrogate Data

The PM_{10} background values are most appropriately taken from measurements at a nearby site, representative of background for the area being studied. Such a site would ideally measure PM_{10} and not be influenced by (1) sources being studied and explicitly included in a dispersion or receptor model, or (2) sources not impacting the study area. This usually means that the site be located in the vicinity of the study area. For a site that meets these prerequisites, the mean annual background for use in the SIP analysis would be the average of the annual concentrations at that monitor over the time period being evaluated (usually 3 years). Ideally, 12 valid 24-hour samples for each quarter constitute sufficient data to calculate an annual average. However, for the purpose of estimating background, less data may be used if it can be shown that an estimate by any alternate method is more reliable.

Dispersion modelers identify specific sets of 24-hour meteorological conditions that may lead to or be associated with high 24-hour concentrations of particulate matter. Also, receptor modelers often group the samples by meteorological "regime" and consider each group separately in receptor analyses. These specific 24-hour sets of meteorological conditions are matched with meteorological conditions on days when measured particulate matter data are available. The measured data collected on days whose meteorological conditions best match the specific conditions are then averaged to obtain a representative background concentration. As discussed above, care must be taken to ensure that sources being explicitly considered are not upwind of the "background" monitor on the days selected.

In the absence of a single monitoring site which is clearly not influenced by any of the sources considered explicitly in a dispersion or receptor model, a number of judgments and adjustments may be necessary to obtain a background estimate. Three alternatives are available. The first alternate method is to exclude the impact of these sources on the monitored background value by using a wind direction analysis. This consists of calculating the average background concentration for those days when the wind direction is such that the monitor is not downwind of a significant source. Monitoring sites outside of a 90° sector downwind of a source may be used to determine background concentrations. The mean annual or seasonal average concentration is the 3-year mean of the annual or seasonal concentrations which are calculated in this manner. If the location of the sources or the frequency of sampling is such that there are an insufficient number of days at a single monitor to calculate a background value which is not influenced by those sources. background may be determined by "compositing" the air quality concentrations from several monitoring sites located in the vicinity of the study area. This composite average concentration may be developed for the time period being studied by selecting the "upwind" site on each monitoring day and averaging these "upwind" values (see Section 5.0 of this Appendix). The mean annual concentration is then the average of the annual concentrations which are calculated by the composite method.

This procedure is greatly simplified for 24-hour cases. The background for a given day or set of meteorological conditions is simply the average of the concentrations at a site or sites that are upwind on the day or days which are selected to represent those conditions.

As a second alternative for using measured data, background concentrations may be derived using site measurements for a different day or year than the time period being studied. Conceptually, using data from the same site but during a different day or year is similar to the first alternative above but additional care must be exercised in showing that the data used are representative of the background sources and climatological conditions during the study period.

As a third alternate, if PM_{15} or TSP data are available, they may be used as surrogates to estimate PM_{10} concentrations. Use of either TSP or PM_{15} data involves the use of ratios, or multipliers, to adjust measured background PM_{15} or TSP to PM_{10}. Then the estimated PM_{10} data would be treated in the same manner as a PM_{10} measurement in the preceding paragraphs. Surrogate data for PM_{10} should only be used if there are insufficient PM_{10} data for use in applying the procedures above. In cases where PM_{10} data are available for part of a year and the PM_{10} monitor is collocated with TSP or PM_{15} monitors, the ratio approach may be used for the remainder of the year when no PM_{10} data are available. The ratio approach is discussed in Section 6.0 of this Appendix.

3.0 Special Considerations For Receptor Modeling

In some cases, receptor models are used for source apportionment at urban or source oriented sampling sites. In such cases, it may be necessary to perform a source receptor analysis on a nearby background receptor so that the background for specific source components can be determined and discounted prior to using the apportionment (as outlined in Section 6.0 of this Appendix). This receptor analysis at a background site may be necessary, for example, to distinguish between locally generated soil dust and that transported into the area. Source apportionment analysis of the background samples should use the same procedures as used for the source analysis. Then the receptor analyses from the background and study monitors are compared. The sources that were identified on both monitors should be noted and the concentations of these sources at the study monitor should be reduced by the amount of their impact at the background site. In this adjustment process, one must carefully select the background days for receptor analysis to make sure they are "upwind" and are not impacted by the sources of concern.

4.0 Summary Of Alternatives For Estimating PM_{10} Background

The preferred method for background determination is to use an upwind PM_{10} site in the vicinity of the study area (air shed, city, or source) under review, which reported data during the time period in question but which is not influenced by the sources in question or by other sources which do not impact the study area. Since such ideal measurements are not always available, particularly for an annual average determination, the alternate methods discussed previously are summarized below, in order of preference.

First Alternative	Use perimeter site(s) in the vicinity of the study area. The effect of nearby sources that are in the modeling analysis must be eliminated through the use of wind direction analysis (annual or 24-hour). A "composite" background value based on several nearby sites and wind direction analyses may be developed.
Second Alternative	Use PM_{10} data from a different days or a different year to represent the day or year being studied.
Third Alternative	Use surrogate data (TSP or PM_{15}), adjusted to PM_{10}.

5.0 EXAMPLE 1 - Compositing Data From Several Perimeter Sites

In the absence of a single appropriate PM_{10} background site with a sufficiently large data base, data from two or more sites in the vicinity of the study area may be combined to provide a composite estimate of background concentration.

For example, assume that there are two sites located on the area perimeter (one to the north and one to the south). The observations from both sites should be sorted by wind direction into three groups:

Group I - days when the Northern site is upwind (use Northern site data for N_1 days).

Group II - days when the Southern site is upwind (use Southern site data for N_2 days).

Group III - days with calms, substantial shifts in wind direction, during the day or with winds predominantly from the east or west (and both sites are upwind). (Use average of data from both sites for N_3 days.)

The Group I, Group II, and Group III days are used to compile an annual average:

$$\text{annual average} = \frac{\sum^{N_1} \text{Group I} + \sum^{N_2} \text{Group II} + \sum^{N_3} \text{Group III}}{N_1 + N_2 + N_3}$$

where N_1 and N_2 are the number of days where only the northern or southern sites, respectively are upwind. N_3 is the number of days where both sites are upwind.

This calculation can, of course, accommodate more than two monitoring sites. Also, a single site may be used if it is generally upwind of the study area, so long as there are sufficient data to represent average upwind concentrations after the days when the source is upwind are removed from the data base.

6.0 EXAMPLE 2 - Use Of Surrogate Data

Most regional monitoring networks contain one or more designated background hi-vol sites and a few have PM_{15} background sites. However, there are relatively few size-fractionated particulate samplers measuring PM_{10} compared with those measuring TSP; and almost all of the former are in urban locations. Therefore, States may not have direct measurements of PM_{10} background available when they prepare their SIP's. The following is the recommended procedure for using PM_{15} and TSP surrogates to estimate PM_{10}, based on an analysis of regional scale PM_{10}, PM_{15} and TSP sites.

The PM_{15} measurements may be used as a surrogate for PM_{10}. The PM_{15} measurement (either annual average or 24-hour) is multiplied by a constant ratio to give an estimate of PM_{10}.[2] The following adjustment applies.

$$PM_{10} = 0.85 \times PM_{15} \text{ (annual or 24-hour)}$$

Reference 3 suggests PM_{15} to TSP ratios of .61 (annual) and .75 (high 24-hour). Using the above 0.85 ratio for PM_{10} to PM_{15}, the following ratios apply for estimating PM_{10} background using a TSP surrogate:

$$PM_{10} = 0.52 \times TSP \text{ (annual)}$$

$$PM_{10} = 0.64 \times TSP \text{ (high 24-hour)}$$

The concentrations to be adjusted are obtained using the procedures in Section 2.0 of this Appendix. The "adjustment" is simply the last step in the process, wherein a TSP or PM_{15} background estimate is adjusted to represent an estimate of the PM_{10} background.

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